Research Note 82-15

SPECIALISED FORMS AND INDIVIDUAL SUBTASKS OF THE TEAM DECISION SYSTEM

Gordon Pask
SYSTEM RESEARCH LIMITED

U. S. Army
Research Institute for the Behavioral and Social Sciences

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A detailed study of decision making in complex command and control systems was carried out using the "Team Decision System" with a "Space" scenario with many novel features. The data is coherent if sufficiently detailed. Prediction of planning is possible.

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Gordon Pask
SYSTEM RESEARCH LIMITED

Edgar M. Johnson
Contracting Officer's Representative

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Submitted by:
Robert M. Sasmor, Director
BASIC RESEARCH

Approved by:
Joseph Zeidner
Technical Director

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

Office, Deputy Chief of Staff for Personnel
Department of the Army

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Basic Research

1. Introduction

A total of 10 subjects, all skilled in previous experience of the Team Decision System (TDS, Fig 1, Fig 2, Fig 3), have completed a series of 3 session experiments, each lasting for several hours, in the 1 commander and 2 craft mode. Program listings for the mini-processor and for an arbitrary number of microprocessors (4 in Fig 3) are presented in Sections 5 and 6. A further 11 subjects gave partial data.

The experimental design is shown in Table 1. It consists in one session run in a "High Difficulty" condition; one session run in a "Low Difficulty" condition, and one, subsequent, session, run in a "High Difficulty" condition. As indicated in Table 1, the other-than-practice experimental sessions are terminated either by an irreversible collapse in the environment, or, if there is no collapse, then at the next interrogation after a 3.5 hour interval.

The first of the high difficulty sessions is called "practice" even though all of the subjects acting as TDS commanders were familiar with the routines and basic operation of the system .The intention was to introduce most of the contingencies likely to be encountered but without the stress of real life operation. Hence, "practice" might be more accurately replaced by "low stress" and laboratory-like, whereas during both the remaining "low difficulty" and the "high difficulty" sessions the mission was realistic. The results obtained from these experiments are presented in some detail.

High Difficulty "Practice" (2-2½ hours) Reinitialise if breakdown	Low Difficulty Until breakdown or 3½ hours (or next interrogation).	High Difficulty Until breakdown or 3½ hours (or next interrogation).

Table 1. Experimental Design

It was only possible (because of the interacting effects of subject attendance and equipment maintenance) to run 2 teams (2 commanders, 4 craft mode of TDS) through the entire 3 session design of Table 1, although there is some team data from partially completed experiments. This data together with the 2 actually completed team series, is recorded and retained on discs, but is not treated statistically in the present report.

1.1. Mission

In each session, the mission is the same, and it is described in previous reports, and publications (Pask, 1979, 1980). A subject acts as a mercenary in charge of spacecraft protecting trade routes between "Starbases" and able (like a mercenary) to "invest" in the "economy" of one or several starbases.

The 4 starbases of TDS have an energetic "economy". The amount of the common currency of "energy" units available to any one starbase depends primarily upon the extent and possibility of trade (by exchanging "barges" or "freighters" along trade routes) and the extent to which starbases or barges are "leached" by adjacent marauding objects ("Klingons"). Next, if mercenaries are employed to maintain and promote trade between starbases (amongst other actions by eliminating Klingons in harmful positions) then it is necessary to provide the spacecraft with energy; a transaction in which a spacecraft docks at a starbase and refuels; provided the starbase has enough energy. This transaction depletes the "energy" immediately available to the starbase although, as noted earlier, spacecraft docked at a starbase may also invest any surplus energy in the starbase economy.

All spacecraft activities have an energetic cost; these activities include movement, mining Klingons to eliminate them, and obtaining any information other than the "frame" or "window" (of size 7 x 7 cells in a 32 x 32 cell space) which is given "gratis" through the local scan display of a spacecraft.

Any action of a spacecraft uses up its energy; inaction is impossible (there is an inbuilt default tactic called drifting). Apart from these features there is an overall constraint upon the operation; improvident expenditure of energy in a region of the "space" environment disrupts the environment by changing its connectivity (by making impassable "holes" in "space" or "cracking" the originally torroidal "space" into cylindrical or even rectangular form, and as a result impeding both trading routes and navigation of the spacecraft). In one sense, these transformations of the environment are "semi-reversible" since only craft cooperation and the expenditure of repair energy permits "holes" to be filled, and "cracks" to be "sewn up". Also, as noted in previous reports, spacecraft may run out of energy (in which case they are lost) and starbases may run out of energy and be eliminated. These transformations, of spacecraft and starbases, are irreversible.

Under low difficulty conditions, all of these events are possible, but, if they occur, are due to some move or moves that could (in principle) have been avoided for there is no serious overload of the commander(s). Under high difficulty conditions there is gross overload and the likelihood of emergencies of any kind is much greater. All but one of the high difficulty sessions are terminated by some "irreversible" change, which may be due, indirectly, to a "semi reversible" change (for example, that a crack is made which disrupts the starbase economy, but one craft is lost so that the act of repairing the crack is no longer possible).

The low difficulty and high difficulty conditions differ due to the leach rate of "Klingons" (the intruders) upon spacecraft energy and starbase energy. Starbase leach rate is 1000 units (high) and 500 units (low). Spacecraft leach rate is 500 units (high) and 200 units (low).

The average number of "Klingons" in the whole of space is held constant and the initial energy levels as well as the initial configurations of spacecraft, "Klingons" and of bases, are shown in Table 2 and Fig 4.

	Energy Units
Ship X	20,000
Ship Y	20,000
Base A	20,000
Base B	20,000
Base C	20,000
Base D	20,000
Klingons	300
Freighters	300

Table 2. Initial Conditions

1.2. Spacecraft and tactic organisation

Anything a commander does (other than replying to interrogation questions) is done through one or more of the spacecraft; that is, through one or more of the potentially independent microprocessors of Fig 3. Tactics are sequences of "If... then... else" statements of any length and may call for the execution of a further tactic . However, a simple command like "move with thrust x in direction y", if unqualified,is also defined as an unconditional tactic. Consequently, either action, or thought of a contemplated action, are exteriorised in the tactics that are assigned to spacecraft (an arbitrary storage limit has not been exceeded) or are transferred between the spacecraft.

It is important to emphasise:

(a) That tactics govern information retrieval as well as operations such as manoeuvering, mining-Klingons, docking, repairing and other more conventionally action-oriented instructions.

(b) That a tactic in one spacecraft may call for another tactic in the same spacecraft or a tactic in a different spacecraft.

1.3. Work Reported

Results from 8 of the 10 subjects completing 3 sessions in the one commander mode (labelled (a) to (h)) are presented in this report since the records from two subjects proved defective as a result of technical difficulties.

Partial, but useful, data is available from 9 of the remaining 11 participants.

1.4. Other differences between the experimental sessions

As noted earlier "practice" sessions is, perhaps, a misleading name. Conditions of high difficulty were employed (as in the following "low difficulty" session) but subjects knew at the outset that a definite time limit existed. If their behaviour gave rise to an irreversible and damaging change in the environment, before this time (2 hours, approximately) had elapsed, the subjects knew that the programs would be re-initialised and, in fact, reinitialisation took place.

Subjects taking part in the "practice" did not necessarily have much involvement, apart from the interest of the task. The mission and initial conditions are the same as in the other "high difficulty" session, but performance is not susceptible to peer judgement , and there is no overt "interrogation" except in terms of (disc stored) log statements.

In contrast, for the other sessions, either "low difficulty" or "high difficulty",there is no (announced or perceived) time limit. Subjects do not know whether there is another commander in the system (in the one person task, they only know that they cannot interact with the other commander who may be very experienced in fast paced, demanding or high risk management operations; for example, an aircraft captain) They do know that such a person will scrutinise their results; that they are responsible for keeping the environment viable, in their role as a mercenary, for as long a spell of duty as possible and they are overtly interrogated from time to time.

1.5. Decision making responsiblity

Elliot Jacques (1956, 1964, 19[illegible]) conceives responsibility and foresight as closely related to a span of successful and unsupervised activity. It seems fair to comment that "other-than-practice" sessions and the "practice sessions" differ insofar as other-than-practice operation does, overtly, require responsible thought and action; consequently, that Elliot Jacques' time span index (1956, 1964) is an approximate

measure of performance in other-than-practice sessions and that an index of the time-span of successful, unsupervised activity is one of its estimators. It is evident that Atkin's proposed indices of dimensionality (1977,1978) are more refined and that the necessary quantification could (and should) be performed. However, the calculations are complex and special programs are needed to perform Atkin's analysis. Within the limits of the year's project it would have been impracticable to arrange for this refinement. It is, however, of interest to note that some measure of that all-encompassing quality "responsibility" is one, and maybe, the only, estimate of "good" decision making.

1.6. Quality

Of course, the question of what, exactly, "good" means, remains open; and there is no reason to suppose that a universal answer is available. The proper answer surely depends upon context dependent desiderata. One important criterion, by no means the only one, is that a decision maker who performs competently under low difficulty (low risk) circumstances is able to perform a comparable task under high difficulty (high risk) circumstances; not, necessarily for so long since overload and fatigue set it. It is also true that the termination of any high difficulty session is likely to occur before termination under conditions of low difficulty. However, the performance should not be "thrown" or perturbed by gross omissions or overreactions if "high" difficulty is introduced.

In summary, whilst style (how a subject deals with manoeuvers, predelictions for a global or a partitioned and stepwise approach) and the conditions under which he does so are (at any rate according to the previous reports) quite reliably as well as readily estimated from stylistic pretests of conceptual and learning style; "Decision Making" is not. It implicates the whole personality and the perspectives, or functional roles, which the decision maker adopts in the conduct of the task.

1.7. Analysis of the Data

Several "grains" or "levels" of analysis of the data are presented in Section 2 of this report; some of them are potentially useful as indicators, or even predictors, of performance, and others (although they are intuitively reasonable and have been employed quite frequently in other studies) seem to have little value in the context of complex decision making. The analyses appearing in the body of the report refer to tactical behaviour and tactic composition; to action and the effectiveness of action in regulating the environment, namely, the "Starbase" economy, the number of "Klingon" intruders in certain regions (near to "trade" routes) and the "energy" which is available at any instant to the spacecraft. An analysis of the state of knowledge (of the 8 subjects for whom comparison is possible) appears in Section 3; namely, interrogation data, consisting in the rectitude and the subjectively estimated veridicality of interrogation session responses.

1.8. Overall differences between the subjects

Amongst the 8 subjects considered,(a) to (h), it seems likely (c) and (e) would, by almost any commonsense criterion, be regarded as "good" decision makers since they maintain the economy viable under both "high difficulty" and "low difficulty" conditions. Subject (a) possibly subjects (d) and (g) might, using similar commonsense criteria, be deemed "good", under "low difficulty" conditions, but not under more serious overload. Neither subject (b), subject (f) nor (h), are successful in either condition but (f), in particular, does have a considerable and manifest tactical ability even though the elaborate and highly interlocked tactics (amounting to a set of strategies) are not used. Subject (c) alone, maintains the environment for longer than the 3.5 hours interval in the high difficulty situation. It seems that a combination of tactical (or strategic) preparation and the ability to use tactics in some coherent manner (patching up deficiencies as needs be) and taking action at an appropriate moment are amongst the ingredients of successful decision making in this environment, which is much faster-paced than the usual simulations and may, perhaps, be compared in pace and reality to a military exercise.

In addition to providing some insight into the character and perhaps the quality of decision making, these experiments reveal numerous trend effects. There are session to session positive or negative transfers of learning, (it was noted in Section 1.4., that the "practice" session is possibly misnamed since all the subjects taking part are familiar with the operation of the TDS).

The effects in question are complex and only a few of them are given special attention as having potential importance and considerable regularity.

(a) The apparent predictability of decision-making skill from data gathered in the "practice" session (which suggests that preliminary test trials of predictive value must be realistic enough to engage the subject in responsible action, thought and planning). The condition obtained in this study by using a high difficulty environment likely to uncover many of the contingencies likely to be encountered later.

(b) The apparent predictability of planning or manipulative skills, special tricks, etc., from relatively static tests for learning or conceptual style, but an insensitivity of the stylistic tests to performance and the management of decision making.

(c) The influence of a "crack" (the most obtrusive "breakdown" in the environment) if it occurs in the low difficulty session.

(d) A prominent but irregular change in the complexity and composition of tactics between the "low difficulty" and the "high difficulty" session.

```
SHIP X TACTICS
    1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18
 1 DCE
 2 MAE CBB DCD CCB ICA SCA
 3 ICA IIA IJA IHA
 4 MBE ICA IJA MBE CFB IJA ICA
 5 MCD CBB DCD
 6 RBA
 7 IJA IDA
 8 MBE CBB DCD ICA SDA
 9 MGB SCA
10MDB SDA
11MGE CCC SFA ICA
12MAB X11
13MEB X 1

SHIP Y SENT THESE
    1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18
 1 MHE
 2 MFB IJA CDB MFB MHE
 3 MHE CDB ICA MHE
 4 DCD CBC ICA
 5 MBE CBB DCD CGC SCA ICA CGB IJA
 6 MEB RBA IJA
 7 MCE X 5
 8 MCE CBB DCD ICA IJA SDA
 9 MCC CBB DCD
10MCB DCD IJA
11MHE SEA Y 1
12MBB
```

Table.3. Format for tactic strings of spacecraft X and format for tactic strings of Spacecraft Y.

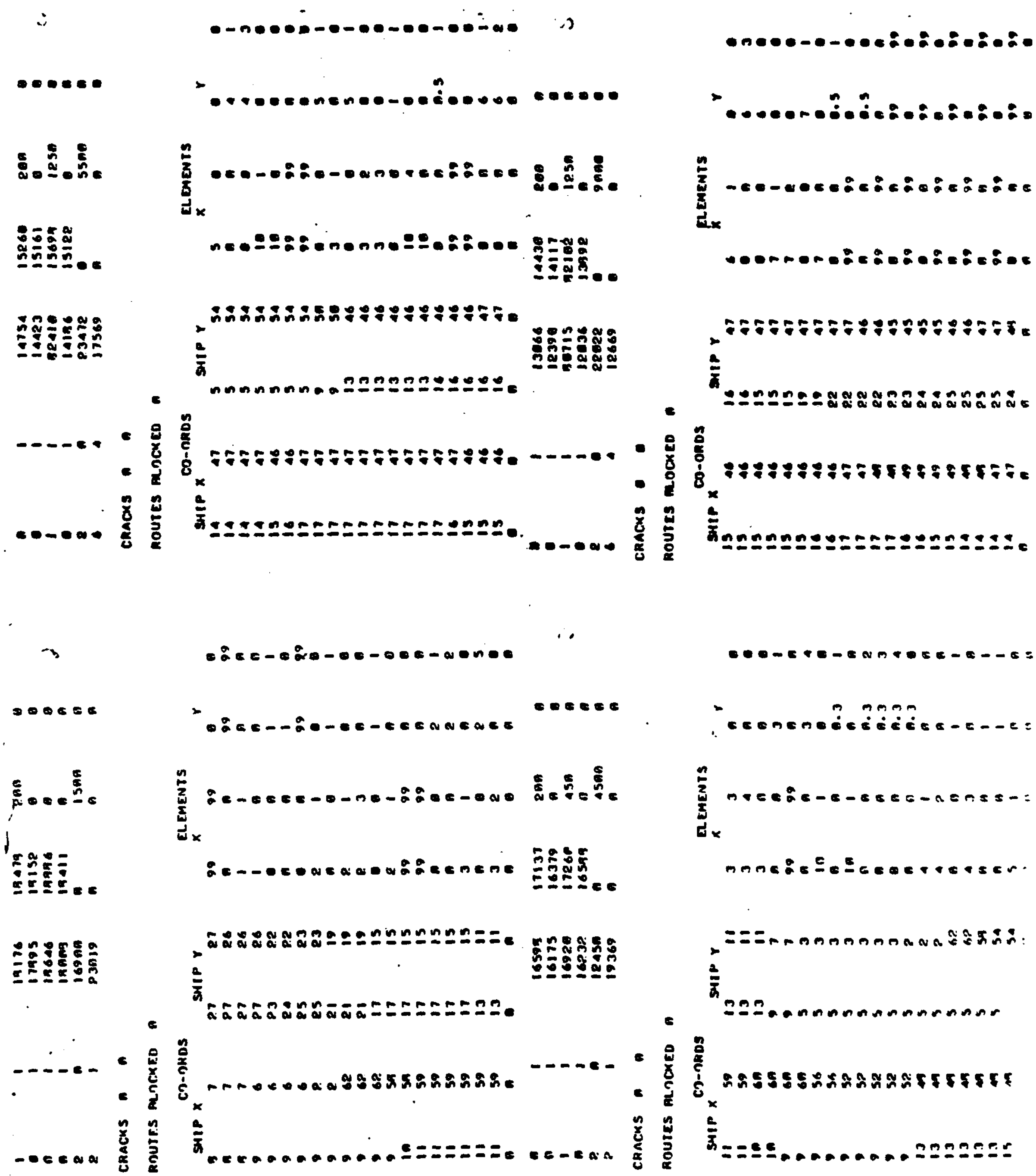

Fig 4: Four low difficulty blocks of record (Subject b)

2

1	1	70856	33622	1800	0
0	1	6231	9152	0	0
0	1	6293	10675	0	0
0	1	5478	8453	0	0
2	0	7950	0	13000	0
10	7	14836	1	0	0

CRACKS 0 1

ROUTES BLOCKED 4

CO-ORDS				TACTICS			
SHIP X		SHIP Y		TACTIC	PART	TACTIC	PART
52	57	17	21	7	1	0	0
52	57	17	21	7	2	0	0
52	57	17	21	0	0	5	1
52	57	16	22	0	0	5	0
52	57	15	22	0	0	99	99
49	60	15	22	9	1	0	0
49	60	15	22	8	3	0	0
49	60	15	22	0	0	0.3	4
49	60	15	22	0	0	0.3	2
49	60	15	22	9	1	0	0
49	60	15	22	9	0	0	0
49	60	15	19	0	0	3	1
49	60	15	19	0	0	3	7
49	60	15	18	0	0	3	0
52	60	15	18	10	1	0	0
52	60	15	15	0	0	6	1
55	60	15	15	10	1	0	0
55	60	16	15	0	0	6	2
58	60	16	15	10	1	0	0
58	60	16	15	0	0	7	1
0	0	0	0	0	0	0	0

4

1	1	70624	70950	1800	0
0	1	940	1128	0	0
0	1	1934	2357	0	0
1	1	47	957	140	0
3	0	5839	0	16000	0
14	7	25900	1	0	0

CRACKS 0 1

ROUTES BLOCKED 4

CO-ORDS				TACTICS			
SHIP X		SHIP Y		TACTIC	PART	TACTIC	PART
61	60	16	15	10	1	0	0
61	60	16	15	0	0	8	1
61	60	17	15	0	0	8	0
61	60	18	16	0	0	99	99
58	57	18	16	11	1	0	0
55	54	18	16	11	1	0	0
52	51	18	16	11	1	0	0
52	51	27	16	0	0	9	1
49	48	27	16	11	1	0	0
49	48	27	16	0	0	9	3
49	48	27	16	11	3	0	0
49	48	35	16	0	0	9	1
49	48	36	16	0	0	9	1
49	48	36	16	12	1	8	0
49	48	35	17	0	0	99	99
49	48	35	17	12	2	0	0
49	48	34	17	0	0	99	99
49	48	34	17	12	1	0	0
49	48	34	17	12	2	0	0
49	48	43	17	0	0	9	1
0	0	0	0	0	0	0	0

5

0	1	66262	67335	1800	0
0	1	-5465	-4278	0	0
0	1	-3244	-2679	0	0
1	1	31441	32865	1740	0
3	0	24932	0	18000	0
19	7	22550	1	0	0

CRACKS 0 1

ROUTES BLOCKED 4

CO-ORDS				TACTICS			
SHIP X		SHIP Y		TACTIC	PART	TACTIC	PART
49	48	43	17	12	1	0	0
49	48	43	17	0	0	9	3
49	48	43	17	12	2	0	0
49	48	52	17	0	0	9	1
49	48	52	17	99	99	0	0
49	48	52	17	0	0	9	3
48	47	52	17	99	99	0	0
48	47	61	17	0	0	9	1
48	47	61	16	0	0	99	99
48	47	61	16	13	1	0	0
48	47	61	16	13	2	0	0
48	47	61	16	0	0	0.3	1
48	47	61	16	13	1	0	0
48	47	60	16	0	0	10	1
48	47	59	16	0	0	1.2	1
48	47	59	16	0	0	1.2	2
48	47	58	16	0	0	1.2	1
48	47	58	16	0	0	1.2	2
48	47	57	16	0	0	1.2	1
39	47	57	16	14	1	0	0
0	0	0	0	0	0	0	0

6

0	1	61193	61736	1800	0
0	1	-10457	-9753	0	0
1	1	38	251	0	0
0	1	25566	26032	1740	0
3	0	20132	0	19000	0
21	7	20350	1	0	0

CRACKS 0 1

ROUTES BLOCKED 4

CO-ORDS				TACTICS			
SHIP X		SHIP Y		TACTIC	PART	TACTIC	PART
39	47	57	16	0	0	1.2	2
39	47	57	16	14	3	0	0
39	47	57	16	14	4	0	0
39	47	57	16	0	0	11	1
38	47	57	16	14	1	0	0
38	47	57	16	14	4	0	0
38	47	56	16	0	0	10	1
21	47	56	16	14	1	0	0
21	47	55	16	0	0	1.2	1
21	47	55	16	14	4	0	0
21	47	55	16	0	0	1.2	2
18	47	55	16	14	1	0	0
18	47	54	16	0	0	1.2	1
18	47	54	16	14	3	0	0
18	47	54	16	0	0	1.2	2
18	47	54	16	14	4	0	0
18	47	53	16	0	0	1.2	1
19	46	53	16	99	99	0	0
19	46	53	16	0	0	1.2	2
20	46	53	16	99	99	0	0
0	0	0	0	0	0	0	0

Fig 5: Four high difficulty blocks of record (Subject b).

2. Experimental Results

Data from the 3 session experiments have been analysed at several "grains" or "levels" of detail. In this section consideration is given, almost exclusively to :

(I) Overall behaviour and performance using standard criteria such as the energy levels of spacecraft, of starbases; the number of trade routes open, and the energy expended in removing "Klingons" (the marauders that disrupt "trade" between starbases).

(II) A more or less detailed analysis of the tactics built up by each subject, either/both prior to/during the mission and (a very different matter, as it turns out) the use made of these tactics and the extent to which spacecraft are coordinated, in fact, whether in a generally mutualistic manoeuvre or by a rational division of labour.

Interrogation data, where available, is analysed in Section 3.

2.1. General Overview

The source data is exemplified for one subject in Table 3 (print out of tactic strings stored in the spacecraft microprocessors) and, also, for one subject in Table 4 and Table 5 (same subject's performance under "low" and "high" difficulty)

2.2. Aims and Methods

The main goal of the analysis is to determine whether(and, if so, in what sense), decision making performance is predictable either from pre-tests or practice sessions (which might readily be implemented as a dynamic test procedure).

Due to the somewhat curious circumstances under which I examined the records and performed the analyses, I adopted an unusual although, once stated, quite legitimate, expedient. Instead of applying non-parametric tests to begin with: later, parametric measures like SD or correlation, etc., I first obtained parametric statistics which are readily computed on a sophisticated H P calculator designed for this purpose. These indices are tabulated, where relevant, even though the data does not always (although it often does) justify the use of such indices. For example, means, standard deviations, and correlations are cited. These, regardless of their statistical justification, are good measures of averages of variability, and of non-causal-relatedness and they should be interpreted as such, ie. as convenient and conventional summaries.

Only when large or apparently significant differences and correlations are manifest, the data is subjected to non-parametric tests, which are quite legitimate according to the canons of statistics . When noted, as distinct figures, data from the 11 subjects who did not complete all the sessions, has been adjoined to the original.

It is clear, on inspection, that statistical canons are not necessarily best suited to data of this type. They are founded upon assumptions of linear, or piecewise non linear relations between quantities and it is

Subject (a)

	(a)	Mean	SD
Pract	A	45.84	26.35
	B	16.16	01.74
	C	15.65	02.13
	D	16.14	06.91
	$\mathcal{E}/4$	23.43	$\mathcal{E}$ 93.73
	X	23.70	01.91
	Y	17.52	22.43
	r(X,Y)	-0.1306, N=4	
		41.22	
Low	A	50.05	17.24
	B	59.25	39.82
	C	34.22	15.53
	D	25.54	17.53
	$\mathcal{E}/4$	42.37	$\mathcal{E}$ 169.5
	X	15.01	02.57
	Y	14.91	05.25
	r(X,Y)	+0.271, N=12	
		29.92	
High	A	63.65	03.03
	B	15.22	02.35
	C	15.96	02.01
	D	15.19	02.70
	$\mathcal{E}/4$	27.50	$\mathcal{E}$ 110.20
	X	18.49	05.37
	Y	75.85	09.13
	r(X,Y)	+0.450, N=4	
		94.34	

Subject (b)

	(b)	Mean	SD
Pract	A	69.64	26.12
	B	28.70	32.06
	C	35.50	12.40
	D	26.42	13.96
	$\mathcal{E}/4$	48.28	$\mathcal{E}$ 19.31
	X	18.52	04.94
	Y	14.84	02.29
	r(X,Y)	-0.770, N=7	
		33.46	
Low	A	16.35	03.04
	B	25.78	09.22
	C	25.30	08.39
	D	12.68	03.62
	$\mathcal{E}/4$	20.02	$\mathcal{E}$ 80.01
	X	10.25	07.63
	Y	10.77	06.39
	r(X,Y)	+0.979, N=7	
		21.02	
High	A	27.12	01.66
	B	10.18	08.52
	C	10.15	06.11
	D	09.70	05.88
	$\mathcal{E}/4$	14.26	$\mathcal{E}$ 57.15
	X	12.48	03.62
	Y	12.33	04.65
	r(X,Y)	+0.233, N=9	
		24.81	

Tables 6 a, b, c, d: Mean Energies of Starbases A, B, C, D. Spacecraft X, Y, and correlations between the energy mean of X and the energy mean of Y. The Standard Deviation of these quantities is indicated as A-D, the $\mathcal{E}$/ 4/ is a mean of mean values and the value is their overall sum.

	Subject (c)			Subject (d)	
	(c) Mean	SD		(d) Mean	SD
Pract	A 40.58	11.01	Pract	A 33.62	18.75
	B 13.09	03.81		B 21.20	05.02
	C 26.36	10.87		C 15.45	02.52
	D 15.73	04.84		D 17.22	02.44
	Σ/4 23.94	Σ95.75		Σ/4 21.87	Σ87.49
	X 16.35	03.95		X 08.70	07.81
	Y 21.48	03.73		Y 14.75	04.13
	r(X,Y) -0.143, N=6			r(X,Y) -0.101, N=4	
Low	A 17.73	08.38	Low	A 23.03	07.06
	B 27.15	13.96		B 24.89	07.23
	C 79.64	33.45		C 19.47	11.68
	D 25.78	12.75		D 48.96	17.51
	Σ/4 37.57	Σ150.30		Σ/4 29.08	Σ116.30
	X 16.40	05.61		X 14.71	05.07
	Y 22.55	09.06		Y 13.84	06.12
	r(X,Y) +0.414, N=10			r(X,Y) -0.090, N=11	
High	A 62.16	21.60	High	A 11.77	04.71
	B 25.92	24.92		B 24.77	12.05
	C 09.80	07.35		C 12.10	04.51
	D 16.20	09.95		D 07.72	06.47
	Σ/4 28.44	Σ113.70		Σ/4 14.09	Σ56.36
	X 32.69	17.88		X 05.70	03.70
	Y 11.72	06.27		Y 12.17	07.76
	r(X,Y) -0.472, N=11			r(X, Y) + 0.878, N=4	

Table 6 (b)

	Subject (e)			Subject (f)	
	(e) Mean	SD		(f) Mean	SD
Pract	A 19.04	03.40	Pract	A 21.86	03.34
	B 32.05	05.86		B 15.26	01.45
	C 20.04	11.20		C 16.86	01.75
	D 22.46	20.05		D 16.30	01.65
	Σ/4 23.39	Σ93.59		Σ/4 17.57	Σ70.26
	X 17.05	03.32		X 05.03	05.07
	Y 22.52	04.04		Y 05.93	05.85
	r(X, Y) - 0.016 N			r(X,Y) +0.992, N=6	
Low	A 12.01	04.34	Low	A 14.76	02.04
	B 11.20	04.74		B 21.24	13.95
	C 16.65	01.36		C 14.65	03.15
	D 38.72	11.57		D 22.94	17.60
	Σ/4 19.54	Σ78.99		Σ/4 18.35	Σ73.53
	X 25.03	14.27		X 15.92	03.07
	Y 08.73	08.76		Y 08.98	03.78
	r(X,Y) -0.747, N=8			r(X,Y) +0.626, N=5	
High	A 26.17	08.66	High	A 33.82	23.13
	B 32.65	13.28		B 11.32	05.69
	C 16.10	06.81		C 08.05	03.38
	D 28.90	16.15		D 32.97	09.40
	Σ/4 25.95	Σ103.80		Σ/4 21.54	Σ86.16
	X 15.46	04.94		X 05.45	07.87
	Y 14.91	04.75		Y 06.77	04.84
	r(X,Y) +0.681, N=8			r(X,Y) +0.743, N=4	

Table 6 (c)

	Subject (g)			Subject (h)		
	(g)	Mean	SD	(h)	Mean	SD
Pract	A	24.75	10.48	A	41.87	10.86
	B	11.64	08.16	B	12.92	04.94
	C	15.52	05.40	C	32.04	10.25
	D	16.00	08.95	D	21.21	05.52
	Σ/4	16.97	Σ67.91	Σ/4	27.01	Σ108.00
	X	25.00	05.28	X	17.64	02.67
	Y	16.45	04.52	Y	16.11	03.53
	r(X,Y)	-0.142, N =		r(X,Y)	-0.201, N =	
Low	A	66.06	20.55	A	16.01	04.61
	B	45.54	18.20	B	80.02	18.98
	C	22.84	05.46	C	21.15	05.67
	D	27.97	08.03	D	50.22	04.21
	Σ/4	40.52	Σ162.40	Σ/4	41.85	Σ167.40
	X	15.72	07.52	X	14.99	03.25
	Y	14.64	09.01	Y	16.05	04.00
	r(X,Y)	+0.252, N=12		r(X,Y)	+0.232, N=9	
High	A	12.60	04.46	A	11.26	06.55
	B	10.26	02.91	B	30.52	09.11
	C	18.82	02.22	C	20.19	09.52
	D	11.50	01.80	D	09.56	02.24
	Σ/4	13.37	Σ53.48	Σ/4	17.88	Σ71.53
	X	19.55	04.92	X	13.25	05.06
	Y	11.02	04.00	Y	11.58	04.94
	r(X,Y)	+0.111, N=5		r(X,Y)	-0.187, N=6	

Table 6(d)

Subject		En(X)	En(Y)
(a)	Low	0	4242
	High	2165	0
(b)	Low	0	0
	High	18612	9962
(c)	Low	30714	18276
	High	5548	53694
(d)	Low	8044	8235
	High	7433	0
(e)	Low	9655	11604
	High	1895	11257
(f)	Low	1029	1685
	High	0	0
(g)	Low	12824	0
	High	1600	1022
(h)	Low	18465	1789
	High	600	1024

Tables 7a, b, c. Energies of Spacecraft En(X), En(Y), of complete investment, of loss to Klingons and Klingons eliminated; of cracks unrepaired as well as holes unrepaired; the energies of Starbases A, B, C, D at the end of "low" and "high" difficulty condition missions (at the end of mission for all subjects).

	Sessions	Invest	Loss	Eliminate	Holes
(a)	12	3883	61500	29	6
	4	1406	12500	0	0
(b)	7	4030	24000	36	2
	9	3212	11000	14	11
(c)	10	9716	29500	20	16
	11	9600	52000	37	10
(d)	11	1021	60500	19	2
	4	2899	42000	7	0
(e)	18	1204	24500	22	16
	18	7106	39000	45	0
(f)	15	255	16000	12	5
	4	500	26000	10	2
(g)	4	1800	25612	22	8
	4	2200	4422	44	2
(h)	4	0	1820	2	7
	4	0	2000	6	4

Table 7(b)

	Starbases				
A	B	C	D	$\Sigma/4$	
8250	12473	2511	1132	6091	Low
7875	1443	1441	1418	3044	High
1199	30437	31013	13686	2178	Low
52753	11560	3560	1805	5571	High
2794	3846	9849	3695	5045	Low
8291	5105	716	2307	4331	High
2436	3066	3847	5283	3658	Low
6605	32920	1373	0034	1023	High
571	448	3269	3896	2046	Low
1833	4035	1924	3841	2900	High
1151	4597	1073	5421	3060	Low
52719	3783	4269	3322	1604	High
7678	11219	2920	12576	8594	Low
15961	2000	4002	8798	7690	High
6304	1129	2784	8406	4655	Low
5780	2188	1909	2250	3031	High

Table 7(c)

questionable if this type (or dimension) of regularity is a fair assumption in the analysis of such data. At least, the implicit assumption is "safe", but alternative and well-founded, but more liberal, analytic methods are available (notably, Atkin's Q-Analysis) and it looks as though they should be employed (quite certainly, in terms of obtaining a broader and just-as-legitimate base for the description and analysis; possibly, to advantage in obtaining more incisive results). Q-Analysis relates to, but is not identical with, the indices noted in Section 1.5. I learn, for example, that the AMTE are currently using Q analysis, experimentally, in this direction with their comparable-to-TDS, HUNK system.

This task has not been attempted

(a) because it is possible to select many equally legitimate frameworks to set up the required matrices

(b) because the post-hoc data manipulation for any one framework is quite burdensome.

(c) as soon as several different frames are tried (which is necessary) the task becomes impracticable as a post-hoc exercise

(d) the most provident approach, and probably the only practical approach, is to build a variety of frames for data into the computer programs that log and condense the on line data flow throughout performance (AMTE do just this).

2.3. Grains of analysis and description.

Table 6 (for 11 subjects) shows the result of taking averages (over one complete session) for such traditionally used indices as the mean energy levels of starbases or of the spacecraft; typically, "Type I" summaries. Quite clearly, an averaging of this kind conceals a number of important and, viewed globally, obvious features of the welfare of the starbase economy; for example, the fact that there is a near breakdown (avoided and ingeniously so, by the subject taking a calculated risk at one point the high difficulty session of Subject c). All the same, indices of that kind are not infrequently employed in economic studies, and, unless over-ridden by commonsense, may even have tenure in the military domain (for example, the lip service, at least, paid to game theory or simulation gaming and the like which do, for all their many virtues, rely upon averages, probabilities and variations from the supposed linear or, at best, piecewise-non-linear paradigm).

Inspection of Table 6 reveals only some rather unimpressive relations which, quite frankly, it does not seem worth pursuing or reporting. There is, of course, a great deal of difference between the subjects, their styles and modes of operation. No doubt a larger sample would give a few statistically significant results. But there is no reason to suppose that a large sample, giving numbers that obey the central limit theorem, would provide a genuinely more discriminating predictor set than an average over the unusually accurate indices obtainable in TDS.

Table 7, which shows the cumulative final values of starbase energies, Klingons demolished, energy spent in demolishing them, numbers of cracks or holes in space, and similar quantities is, perhaps, marginally more informative than Table 6, but it scarcely provides the kind of information

Blocks	Mission Difficulty	Subject label	Interactions	Conditionals	Information obtained and available as result of tactics	No Instructions	No Tactics	Instructions	Tactics	Transfer Statements		
12	Low	(a)	1.04	1.87	3.41 L	71	19	11	8	5		
9	High		0.75	1.25	0.50 H	52	15	3	7	8		
7	Low	(b)	0.06	2.92	2.35 L	86	27	20	7	4		
9	High		0.44	2.77	3.44 H	102	42	22	10	8		
9	Low	(c)	2.43	3.11	2.44 L	84	25	19	15	10		
11	High		2.22	2.27	2.54 H	152	52	37	17	8		
11	Low	(d)	1.77	0.81	0.81 L	67	29	10	7	1		
4	High		1.50	0.37	0.50 H	40	15	3	4	0		
8	Low	(e)	2.37	1.87	1.06 L	55	21	6	4	2		
8	High		2.43	3.00	2.63 H	99	27	17	19	4		
5	Low	(f)	0.20	2.10	1.90 L	38	15	8	5	2		
4	High		0.01	3.36	2.12 H	55	23	11	8	4		
12	Low	(g)	2.24	1.12	1.05 L	80	24	12	8	4		
9	High		1.34	0.46	0.52 H	146	32	5	6	4		
6	Low	(h)	0.04	0.75	0.64 L	25	18	11	8	2		
5	High		0.24	0.35	0.52 H	56	16	2	6	0		
10	Low	(o)				70	42	14	4	9		
8	High					50	50	8	2	6	110.0	46.0
9	Low	(p)				41	11	11	1	2		
5	High					67	26	12	4	4	54.0	18.5
12	Low	(q)				98	25	6	17	5		
6	High					26	45	8	11	3	112.0	35.0

Table 8

	Subjects	UM	XM	RM	UC	XC	RC	MM	MC	N	O	C	V
Full Sessions	(a)	0.87	0.00	0.23	0.60	0.04	0.36	0.36	0.33	72	80	88	59
	(b)	0.27	0.00	0.30	0.04	0.27	0.35	0.19	0.22	91	76	84	66
	(c)	0.08	0.05	0.05	0.47	0.28	0.57	0.30	0.44	85	75	79	88
	(d)	0.00	0.00	0.10	0.65	0.33	0.58	0.03	0.52	66	71	72	67
	(e)	0.00	0.08	0.00	0.70	0.30	0.76	0.04	0.58	87	87	70	64
	(f)	0.35	0.63	0.08	0.09	0.21	0.33	0.35	0.21	70	65	73	58
	(g)	0.44	0.17	0.13	0.15	0.20	0.54	0.24	0.29	84	89	60	70
	(h)	0.13	0.18	0.17	0.23	0.05	0.28	0.16	0.18	28	55	34	60
No High	(i)	0.33	0.12	0.24	0.58	0.16	0.86	0.23	0.53	54	73	63	47
	(j)	0.05	0.07	0.00	0.47	0.20	0.76	0.04	0.48	97	33	65	56
	(k)	0.08	0.21	0.37	0.25	0.08	0.23	0.22	0.56	15	65	61	31
	(l)	0.20	0.14	0.06	0.15	0.14	0.50	0.13	0.18	85	16	78	10
	(m)	0.26	0.16	0.01	0.50	0.47	0.61	0.14	0.52	66	68	60	33
	(n)	0.00	0.13	0.19	0.70	0.18	0.34	0.10	0.40	72	55	63	27
No practice	(o)	0.01	0.25	0.06	0.56	0.45	0.50	0.11	0.50	40	88	34	78
	(p)	0.29	0.32	0.18	0.50	0.05	0.24	0.26	0.26	83	25	76	15
	(q)	0.55	0.54	0.34	0.61	0.50	0.77	0.47	0.63	84	84	79	73

Key: UM, XM, RM = Confidence estimates of "if mistaken" on U, X, R subscores
UC, XC, RC = "Correct" confidence estimate on U, X, R, subscores
MM, MC = Degree of belief in correct and mistaken
N = Neutral score
O = Operation Learning
C = Comprehension Learning
V = Versatility.

Table 9: Results obtained from tests for conceptual style and administered to all subjects participating as commanders in the experimental sessions (some before, some after and some in the course of the sessions).

(a)	Prod	06.18	06.63	00.47
		(5)	(12)	(9)
	Sum	08.50	02.11	00.83
	Av. Miss Pr.	012.36	055.25	005.22
(b)	Prod	00.64	00.42	00.04(8)
		(7)	(7)	(9)
	Sum	19.23	02.14	02.22
	Av. Miss Pr.	000.91	000.60	000.44
(c)	Prod	16.08	18.43	12.08
		(12)	(9)	(11)
	Sum	26.16	26.93	23.40
	Av. Miss Pr.	133.30	204.30	109.80
(d)	Prod.	000.66	01.16	00.28
		(8)	(11)	(4)
	Sum	09.66	01.60	00.79
	Av. Miss Pr.	008.25	010.54	007.00
(e)	Prod.	04.24	05.69	01.92
		(7)	(8)	(8)
	Sum	25.96	19.40	26.86
	Av. Miss. Pr.	060.57	071.12	024.00
(f)	Prod.	00.16	00.79	00.07
		(7)	(5)	(4)
	Sum.	13.43	03.56	18.30
	Av. Miss. Pr.	002.85	037.57	001.75
(g)	Prod.	00.59	02.63	00.32
		(10)	(12)	(9)
	Sum	08.63	01.47	07.73
	Av. Miss. Pr.	000.59	021.91	003.55
(h)	Prod.	00.08	00.19	00.32
		(5)	(6)	(5)
	Sum	04.63	04.36	03.70
	Av. Miss. Pr.	000.15	003.16	000.80
	Prod Mean	3.578	4.4492	1.902
	Prod SD	5.527	6.136	4.158
	Av. Miss Pr. Mean	2.737	5.055	1.907
	Av. Miss Pr. SD	4.731	6.698	3.744

Table 10. Product scores and their average over complete session (number of blocks shown in brackets) and summative scores (which are related but less discriminating as well as less well justified) derived from the data exhibited in Table 8. Subject (a) to (h) means and subject SDs (there is obviously a great deal of subject variation) are shown on lower part of the table. All subsequent analysis based upon product scores.

. Summary scores for complete series :.

Subjects (a) to (h) and subjects who have completed at least two sessions in sequence (in several cases (o) to (q) the reason for the omitted session is technical, the practice records are imperfect leaving only two sessions).

	Subjects	Practice	Low	High
Full Sessions	(a)	06.18	06.63	00.47
	(b)	00.64	00.42	00.04(8)
	(c)	16.08	18.43	12.08
	(d)	00.66	01.16	00.28
	(e)	04.24	05.69	01.92
	(f)	00.16	00.79	00.07
	(g)	00.59	02.63	00.32
	(h)	00.08	00.19	00.04(0)
No High	(i)	06.00	07.05	
	(j)	00.11	00.21	
	(k)	00.23	00.46	
	(l)	03.02	04.80	
	(m)	00.54	00.61	
	(n)	00.73	00.90	
No prac-tice	(o)		06.04	04.07
	(p)		00.32	00.22
	(q)		00.40(6)	00.31

Table 11.

Variables related	r_s	Z
Nx	+0.587	1.856 *
Ny	+0.163	0.515
NR	+0.311	0.983
Ox	+0.427	1.400 *
Oy	+0.444	1.403 *
OR	+0.118	0.373
Cx	-0.440	1.404 *//
Cy	-0.256	0.810 //
CR	+0.185	0.585
Vx	+0.973	3.076 *
Vy	+0.598	1.890 *
VR	+0.306	0.967
VF	+0.250	0.791
VG	+0.250	0.791
xR	+0.349	1.104
yR	+0.295	0.932

Table 12: Rank correlations for 11 relevant subjects. between stylistic test scores N, O, C, V and the mean number of instructions (x) given (not as a rule used) and (y) the number of tactic strings. Also, between N, O, V, C scores and F the low difficulty use; G the high difficutly use and R the mean use.

R = Mean <u>use</u> of tactics over low <u>and</u> high difficulty missions.
* = sensibly significant values
//= negative values

from which decision making performance could be predicted with any real (not just statistical) confidence at all, and the quantities are mostly tabulated as they stand, without analytic scrutiny.

The differences between Table 6 and Table 7 may be, characterised as different "grains" of scrutiny of data "Type I" and are thus tagged for reference at a later stage as Type I(1) and Type I(2) data. In this study it happens that the distinction within Type I is not at all outstanding, but this is probably accidental and the differentiation has potential value.

Tables 8, 9, 10, 11, are much more illuminating. They show one (of many possible) analyses of tactic composition and tactic deployment during task performance, ie. the use made of the exteriorised mental resources invested by a subject and used or not at the moments when contingencies in the environment render them desirable or even necessary resources. These tables, show in other words, one of many types of detailed analysis of "Type II", in sharp contrast to the gross measures (Type I), presented in Tables 6 and 7. In the sequel, attention is directed primarily to these Type II indices.

Again, but in this case, more usefully, it is possible to discriminate grains within Type II, notably to distinguish between detailed and careful but static analyses of tactics stated (Type II(1)) and the dynamic examination of those (as well as those kinds of) tactics not only stated but employed (Type II (2)). Both kinds of data are informative but it appears that Type II(2) is of peculiar predictive value.

Table 8 is formed by examining the data concerned with tactics that are stated but not necessarily (and often are not), frequently employed in practice. The figures are obtained, in this case, by inspection and hand manipulation from tactic printout, exemplified by Table 3. The tactic strings are decomposed into types of statement (conditional, transfer of control between spacecraft, obtaining information, movement, etc.), without reference to how, or how often, the tactics in question were employed. Such categories, although not unique, give a fair picture of tactics available to a commander and thus a summary of the extent to which the commander planned ahead; this account is an imperfect record of action and is defective as a record of planning insofar as it does not stipulate when tactics are created, only their order of construction (ie. the record does not show whether tactics are built up well before their potential use or whether they are constructed just before they are used). This deficiency could, and should, be remedied in future versions of the logging program but in the present case, under unusually fast moving conditions, when coherent action depends upon anticipation and foresight (as confirmed, empirically by examining the commander's personal log data, monitored at each interrogation session) the record is a fair estimate of planning complexity, even planning skillfulness, but not, as already stressed, of the use or deployment of tactics that have been planned.

Table 9 shows scores for the 17 subjects on the relatively static Spy Ring History stylistic test, (ie. of the 10 who completed the series 3 sessions, of whom 2 were excluded because of a program or possibly hardware defect, leaving 8 in all with perfect records), plus the other 11(who failed to attend throughout all of the sessions). Because of this it is possible to correlate the "Spy Ring History test" scores, an index of conceptual style, for the 8 complete records only or, in some cases where data about tactics (like Table 4) are available for some but not all sessions, with this index of style for a larger number of subjects. Both figures are cited in the sequel, with proper annotation, as a means of strengthening some conclusions which may be drawn from examination of the 8 complete (3 session) records.#

Table 8 and Table 9 present the Type II(1) data.

In contrast, Table 10 is a summary of the Type II(2) data which is garnered, with much greater difficulty, after the event (future versions of the data logging program could, and should, incorporate an on line and computerised data summary of this type, which is a routine matter once "this type" has been discovered).

In order to compose Table 10 it was necessary to analyse performance data exemplifed by Table 4 and Table 5 (the complete behaviour data in which tactic use is referenced by the numbers assigned to tactics) . This process is arduous if performed by hand, since, for examole, Ship X Tactic 15, or Ship Y Tactic 16, have, as a rule, different meanings for different commanders and also, in general, for the same commander at different sessions. In order to determine the meaning or meanings of the tactics it is necessary to refer to the tactic listings (exemplified by Table 3) and to search for the occurence of whatever a used tactic does mean at the moment it is used.

However, having done this, we obtain an exceptionally detailed picture of what exactly goes on . The picture is summarised for each subject and each session in Table 11 where tactic use is aggregated in terms of interactions between spacecraft (X or Y), of conditional statements used, and of information statements used. The product of these terms is one (adequate but neither unique nor necessarily optimum) method of obtaining a numerical value for the presence of all of these ingredients. One set of figures

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The latest form of the "Spy Ring History Test" was employed in this study. It differs from previous forms only in the scoring scheme; in the latest form, "versatility" score is presented as a measure of successful "prediction"; of "going beyond the information given" and without the recall weighting. Further, the confidence estimates are scored independently (ie. they do not enter into the calculation of the "versatility" or "comprehension" learning or the "operation" learning scores), so that for each type of Question in the test (ie. those scoring on versatility, on comprehension, and on operation learning) it is possible to tabulate a "confidence correct", or "confidence mistaken" and an overall correct or mistaken degree of confidence, in the answer furnished.

The latest form of the test was recently shown, in a different experiment with 74 subjects, to have greater discriminating capability.

in Table 11 refers to an entire mission, the number of interrogation sessions being recorded. The other set of figures is a "per session" index, obtained by regarding the interrogation sessions as episodal "punctuation marks" and dividing by the number in a mission. Values of a summative index are also shown.

Table 12 is a statistical summary of the Type II(1) and Type II(2) analysis of tactics and the use made of them.

2.4. Main Conclusions and General Results

As promised in Section 1.8. the data and summary tables indicate (Section 1.8(a)) that the indices reflecting the use of tactics do correlate, for each of the 8 recorded subjects, from session to session ie. practice in high difficulty conditions, a mission under conditions of low difficulty and a subsequent mission under conditions of high difficulty (as specified in Section 1.1). Since this appears to be so for the product moment coefficient, Spearman's r_s is also recorded in Table 11. Assuming that =

$$Z = r_s \times \sqrt{N - 1} = r_s - \sqrt{7}$$

(ie. that the distribution of r_s approaches the normal for N = 8) the resulting Z values are:

Z Practice/Low = 2.32
Z Low / Hign = 2.48
Z Practice/High = 2.48

which reach significance at $0.01 > p$, the former only marginally.

However, if the partial data from the 11 subjects who did not complete all the sessions is adjoined (and it is available for "practice" and "low" in 6 cases) the values of r_s are little changed (0.901 in contrast to 0.873) but the Z value for N = 8+6 = 14 becomes
Z Practice/Low = 3.24 N = 14 = 8 + 6
which reaches significance at $0.001 > p$.

A similar "trick" of "adjoining" partial data can be carried out for 3 subjects who do not have records for the practice session. This provides figures:

$r_s = 0.83$, Z Low/High = 2.63 N = 11 = 8 + 3

which is significant at $0.005 > p$, and again lends numerical weight to the correlation beliwed to exist.

Apart from the disquiet voiced in Section 2.2 about the applicability of fundamental statistical assumptions in the proper analysis of this type of data there are no obvious deficiencies in calculation with the "trick" of "adjunction" (it is no more suspect than using matched but unequally sized samples, taking "sessions" as the equivalent of "matched").

Regarding the influence of learning upon the overall results (and learning of some kinds undoubtedly does take place) we are anxious to demonstrate that the practice session with reinitialisation under high difficulty conditions is not significantly worse than the mission under high difficulty conditions. In fact, it is the case (for the 8 complete record subjects) that performance, either as judged by the mission average or the average over interrogations, invariably true that the "practice" session at high difficulty proves superior to that in the high difficulty "mission".

In all but one case (Subject (b)) there is a not altogether surprising trend, which indicates that the results are not due to familiarity.

Performance low difficulty mission $>$ Performance Practice (at high difficulty) $>$ Performance high difficulty mission.

Jonckhere's trend test, applied to this data, shows that a trend is significant at $0.01 > p$.

2.5. Other Findings from the Research

Section 18(b) states that there is a significant correlation realting static tests of conceptual style.

In order to exhibit this point, I have chosen an accessible-to all subjects (that is, 8 with complete records and a further set of 9 having incomplete but useable records) index of tactical complexity: the mean value, over sessions, of instructions in tactics and distinct tactics (shown in Table 8). There is a significant ($0.01 > p$) as well as interesting, correlation between at least the versatility score on the test for conceptual style and the index of tactic complexity (N = 11, 8+3), and a modest, although positive, correlation with the product index, already noted, which comprehends both the planning and the use of tactics in on line performance of the decision task (notice, however, that N = 11, also in this case). We may however, compare "Low Difficulty" session index and the stylistic test scores for all 17 subjects for which there is a correlation of 0.561.

The rank correlation coefficients (r_S) and the Z values collected in Table 12 for 11 relevant subjects, furnish numerical and legitimate support for the claims of Section 1.8(a) as well as those of Section 1.8(b). The stylistic test scores have been correlated with the number of tactic strings and the total number of instructions in each tactic string (the "static" Type II(1) indices) averaged over both high and low difficulty sessions (x and y of Table 8). The index R of Table 12), "dynamic index of tactic use (Table 11), but once again averaged over both high and low difficulty missions. Variables F and G are rankings of the dynamic performance from the Low Difficulty (F) and the High Difficulty (G) mission.

First x (number of instructions) is a more rationally defensible variate that y as an index of planning ahead; next, the V score correlates strongly with this variate (so, to a lesser extent, do the O and N scores). Oddly perhaps, the C score (Comprehension learning) correlates negatively with either index of planning although there is a modest positive correlation with R (the "dynamic" or tactic use index).

Versatility, V, which is a very fair predictor of planning ability, correlates positively but not significantly with R and a similar comment applies to F or to G. It may thus be concluded that V, whilst a good predictor of planning, is not so good as a predictor of actual decision making.

It was stated in Section 1.8(c) that one pronounced learning trend is a regular difference in high difficulty mission performance according to whether or not a "crack", the most obtrusive disruption

of "space" occurs during the preceeding low difficulty mission (when the "crack" is reasonably attributable to improvident energy expenditure in Klingon elimination). The effect of a low difficulty mission "crack" if it occurs, is invariably an overly cautious approach to Klingon elimination and energy expenditure, for some subjects only over the first few, interrogation-punctuated, segments, but for others throughout the entire mission. This effect is best observed by scrutinising the summary Table 6 and Table 7 but deserves attention because a training procedure could be devised to counter it.

It was stated in Section 1.8(d), that there is a prominent but idiosyncratic change in the complexity of tactics that are planned but not necessarily, used, from the low difficult mission to the high difficulty mission. There is invariably a difference but inspection of Table 8 is sufficient to show that the sense of the difference depends upon the subject and so far as I can see is not related in any predictably useful way to performance quality.

2.6. Summary of Main Results of analysis of tactics and behaviour

Inspection of the summary tables and the tables showing their origins strongly supports the view that if a detailed and structural analysis is performed (in practice, it is better done by a program operating on line), then the construction and use of tactics is predictable from session to session and under different conditions of difficulty. The Type II(2) analysis presented and discussed in this report is not optimal, but an informed guess in the right direction. By way of contrast, neither Type I(1), Type I(2) or Type II(2) analyses, of lesser "grain" or detail, show great regularity from session to session in the design described and have little obvious bearing upon the behaviours and intentions that make up the decision process.

(A) Type II(1) analyses, derived from tactic listings and taken to be representative of planning capability, do correlate significantly with the "Spy Ring History" Stylistic test scores. In fact, almost self evidently under the experimental conditions which require rapid action, the existence of a coherent plan is a prerequisite for the effective use of tactics and a commonsense interpretation of effective decision making. But a lengthy set of tactics or a tendency to make many stage tactics is not a particularly reliable indicator of coherence. For example, in Table 8, subject (c) (who unequivocably performed well) has 52 tactics containing 152 instructions in the high difficulty condition; 25 tactics containing 84 instructions in the low difficulty condition. Whereas subject (b) (who unequivocably performed not-so-well) has, again from Table 8, 42 tactics containing 102 instructions under high difficulty conditions and 27 tactics containing 86 instructions for the low difficulty condition. Sometimes, the ordering of "high difficulty" in contrast to the "low difficulty" numbers may be inverted, as shown for example, by comparing (Table 8) subject (d) with subject (e) in this respect.

(B) The coherence of tactics may perhaps be inferred indirectly, from the constitution and type of the tactics listed. For instance, the "information" instruction, "conditional" instruction, and "transfer" instruction sums of Table 8 are quite interesting.

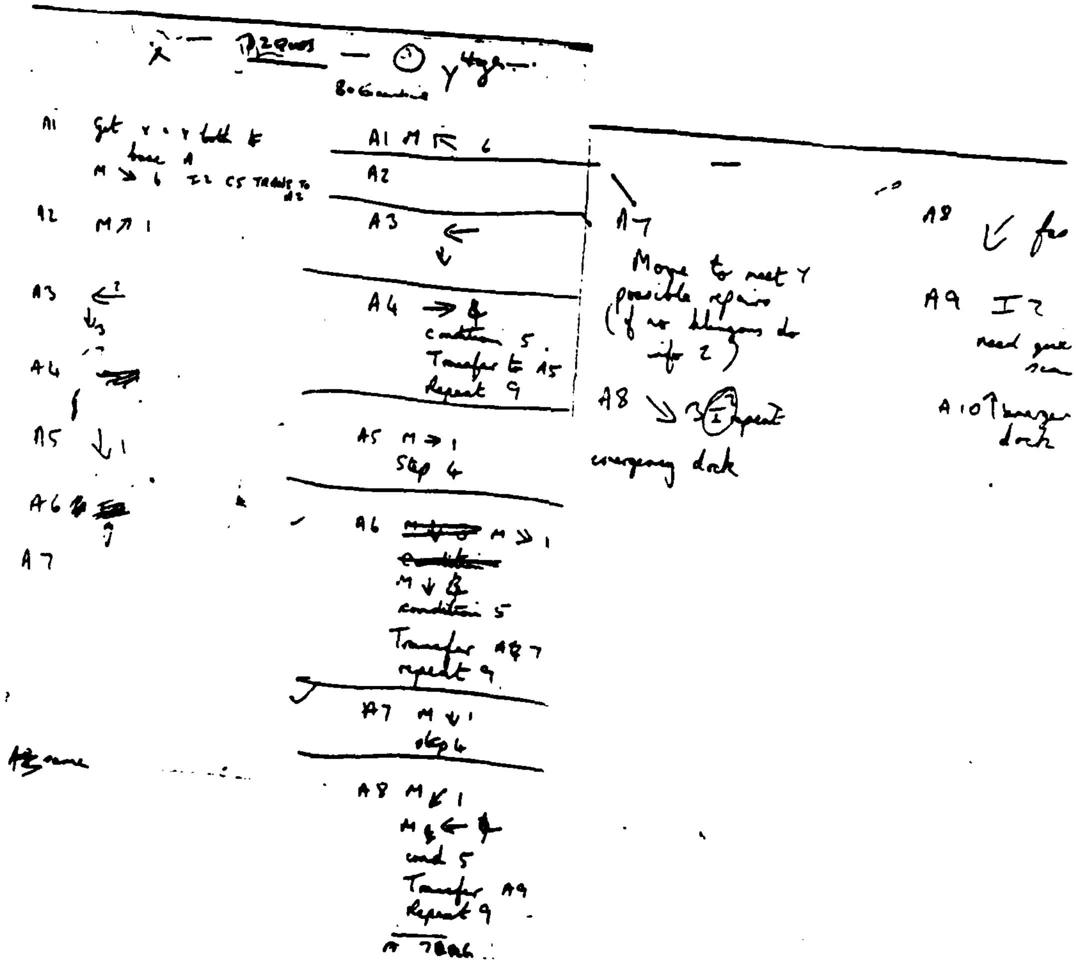

A1 M 6
A2
A3
A4 condition 5
Transfer to A5
Repeat 9
A5 M 1
Step 4
A6 M 1
M
condition 5
Transfer A8 7
repeat 9
A7 M 1
step 6
A8 M 1
cond 5
Transfer A9
Repeat 9
A7
Move to meet Y
possible repairs
A8
emergency dock
A9
A10
dock

Table 13

Y DV4 Low
240 Executions

A1 M ↑, I2, C11 Destroy, Repeat	A1 ↖ M I2 repeat
A2 To dock since near C M ↗, I2, repeat	A2 To dock since near A M ↙, repeat
A3 ready for dock so now could destroy so ← M3 ~~repeat~~ C11 Destroy	A3 ~~M ↓ C11 D3 Rpt~~ circle to see freighters arrive
A4 ↙ dock and circle move	A4 Goto B since A OK and Y OK M ⇒5, C11, D3, I1, I2 repeat
A5 goto D now as C should be OK M→7, C11, D4, ~~I4~~, R5	A5 destroy Kelingons since trade impeded C11, D3 ~~Rpt~~ M ↙ 7 C11, D3 R
~~A6 Bases OK so now get detailed info~~ No good I1, 3, 4 Repeat	A6 C11 D3 M ↙ repeat Go to C
	A7 Y low return to ...

Table 14

However, this or some more refined breakdown, is only a predictor given further background. It is thus suggested that coherent tactics, planning, or whatever is a prerequisite for effective decision making, but is not a sufficient condition to predict its occurrence. Prediction, insofar as it is possible, depends upon examining, also, how the tactics available are, in fact, used (the figures for interactions, cited in subsequent tables, are only derivable from this kinetic data; the conditional and the information instruction frequencies rely upon a kinematic analysis of the actual performance).

(C) Results from the "Spy Ring History" test for conceptual style are of use in determining the mooted prerequisite; they are not very strongly correlated with individual performance, but are likely to prove valuable in the context of group decision making where, for example, it may be possible to combine someone with planning ability (high versatility) and someone able to act incisively if only the plans or tactics were to hand (sometimes, at least, a person with high comprehension learning scores).

2.7. Other methods of Viewing Data

Numerical indices are not the only, or even the best, method of giving substance to tactical and behavioural data. For example, it is possible and informative to plot the positions of the spacecraft as they move on their mission. These plots, exemplified by Fig 6 to Fig 12 give a fair graphic account of what is happening. To add data (currently obtained at the unequally spaced interrogation sessions but available, if desired, at equal intervals), would render the pictures more meaningful (ie. state of vehicles, of space, and of energy expended). Perhaps it is more meaningful still to adjoin an appropriate condensation of the subject personal log, firmed up at each interrogation session (Tables, 13 and 14). These personal logs have for example, served already to explain, in retrospect, the general findings of the analysis so far carried out.

The main difficulty is that static pictures, thus augmented. become exceptionally complex, and visually confusing. It seems likely, however, that this potentially valuable descriptive mode could be utilised if the complex images were presented through an interactive and dynamic computer-graphics-display system.

2.8. Recommendations regarding the analysis of tactics and behaviour

Recommendations are as follows:

(a) To refine (one or more) indices of Type II(2).

(b) To write programs for on-line data collection, in this form, and on-line analysis of the data.

(c) To adopt (one or almost certainly several) bases from a Q analytic approach, especially to capture the relations of balance that determine stability of the starbase economy or any other organisation and which are concerned with Type I(1) or even Type I(2) . Similarly,

to write programs for data collection and data analysis with respect to all Q analytic indices (which is in accord with current experimentation in the AMTE).

(d) To examine more closely the ability of stylistic tests, such as the Spy Ring History test for conceptual style, to predict the planning capability of individuals (not their decision making performance).

(e) To examine the use of the "Spy Ring History " test, or other style revealing instruments, for the purpose of selecting individuals in the composition of a decision-making group or their role-suitability in a team

(f) To recognise, in the context of Eliott Jacques "time span" analysis that the "time span of responsibility " is not a simple issue of how long a mission is or even of how many blocks punctuated by interrogation sessions it contains. At least, it depends also upon the kind of event encountered or intended and it seems likely that an appropriate span index is minimally derivable from Type II(2) data, probably augmented by Type II(1) data. More generally, proper determination of a "span", in particular, a "span of responsibility" calls for an episodal kind of analysis which is cleverly enough devised to highlight, rather than obscure, the fact that episodes occur and interact concurrently; they are seldom, if ever, linearly sequenced.

(g) Given the caveat, of (f) above, to examine the conjecture of Section 1.5., that responsibility is about the only index of effective decision making.

(h) To find, or to develop, interactive animated graphic facilities for displaying complex performance images (Section 1.7) in a cogent and intelligible manner.

	Subjects	Practice			Low			High			Mean			ε		
		C	M	P	C	M	P	C	M	P	C	M	P	C	M	P
Full Sessions	(a)	0.61	0.25	0.46	0.54	0.35	0.53	0.73	0.56	0.59	0.63	0.26	0.53	1.88	0.80	1.50
	(b)	0.47	0.35	0.44	0.32	0.55	0.50	0.54	0.20	0.34	0.44	0.36	0.43	1.34	1.10	1.28
	(c)	0.73	0.44	0.69	0.75	0.42	0.67	0.72	0.12	0.65	0.73	0.33	0.67	2.20	0.98	2.01
	(d)	0.63	0.48	0.52	0.81	0.66	0.74	0.82	0.30	0.75	0.75	0.48	0.67	2.26	1.44	2.01
	(e)	0.81	0.56	0.77	0.85	0.64	0.80	0.82	0.15	0.79	0.83	0.45	0.78	2.36	1.35	2.48
	(f)	0.42	0.58	0.52	0.60	0.43	0.57	0.71	0.49	0.58	0.58	0.50	0.56	1.73	1.50	1.67
	(g)	0.59	0.40	0.54	0.61	0.55	0.60	0.91	0.26	0.84	0.70	0.44	0.66	2.11	1.32	1.98
	(h)	0.64	0.53	0.57	0.66	0.83	0.74	0.69	0.47	0.60	0.66	0.40	0.64	1.99	1.21	1.91
No high	(i)	0.67	0.29	0.58	0.64	0.34	0.56				0.65	0.32	0.57	1.31	0.63	1.14
	(j)	0.75	0.52	0.66	0.73	0.85	0.82				0.74	0.69	0.74	1.48	1.37	1.48
	(k)	0.69	0.54	0.59	0.75	0.91	0.80				0.75	0.73	0.69	1.49	1.45	1.39
	(l)	0.57	0.55	0.56	0.77	0.82	0.79				0.67	0.69	0.67	1.34	1.37	1.35
	(m)	0.44	0.32	0.40	0.55	0.52	0.54				0.49	0.42	0.47	0.99	0.84	0.99
	(n)	0.68	0.61	0.67	0.71	0.65	0.69				0.69	0.63	0.68	1.39	1.26	1.36
No low	(o)				0.95	0.83	0.94	0.90	0.22	0.84	0.92	0.53	0.89	1.85	1.05	1.70
	(p)				0.67	0.59	0.64	0.60	0.34	0.45	0.64	0.46	0.55	1.27	0.93	1.09
	(q)				0.42	0.50	0.46	0.46	0.31	0.50	0.44	0.40	0.48	0.88	0.81	0.96

Table 15

3. Interrogation Sessions

This section consists in an initial analysis of the question and answer interaction of the blocks in which the participating commanders are interrogated by an automatic process that fills in syntactically ordered (commonly "Why", or "What", or "Who" or "Which" or "How" or "Why" or "How many" or "What choice" types of question)in which the content is filled in as a result of the behaviours and is thus relevant to their performance (Pask 1980).

No attempt is made to furnish a complete analysis since the analytic task proved more than expectedly arduous due to the potential richness of the data. Even so, the results are interesting. A fuller analysis will appear in a technical note.

3.1. General Data

It is a relatively simple matter to calculate the degree of confidence (on the 0 to 9 scale) for all subjects and to classify the index as confidence in correct responses (C), in mistaken responses (M) and to adjoin an index, P, to take account of the fact that some questions are intentional or otherwise-not-open to "correct" or "mistaken" marking, even when the actual conditions are determined.

The results of this gross analysis appear in Table 15. The most obtrusive features are a uniformity of confidence pattern (when interrogation sessions are scrutinised in sequence, there is an increasing trend). The next feature of importance, exhibited by all 11 relevant-to-comparison-subjects, excepting subject (a) is a decrease in confidence over in fact mistaken responses under High Difficulty in contrast to Low Difficulty conditions, an increased caution under more stressful conditions.

3.2. Other Results

There is only a modest correlation between the confidence estimates, or degrees of belief, obtained with respect to questions in the stylistic tests and the confidence estimates obtained, by interrogation whilst the task is in progress. Subjects, reasonably enough, regard answering questions about material they have learned in the stylistic test and on line questions somewhat differently (as an interesting but again intuitively reasonable result, they overestimate confidence in mistakes to a lesser degree in the test than they do in real life operation). For 17 subjects the correlation coefficients for confidence in correct (MC, C), for confidence in mistaken (MM, M) responses, are shown below; noting that only some interrogation questions can be answered in a definitely "correct" or definitely "mistaken" manner (ie. the P index is excluded).

MC; Mean = 0.408, SD = 0.152. C; Mean = 0.677, SD = 0.134

$f(MC,C) = +0.199$

MM; Mean = 0.186, SD = 0.154 M; Mean = 0.475, SD = 0.140

$r(MM,M) = -0.400$

By way of a preliminary analysis I have tentatively classified the interrogation responses as "globally relevant" (hence, related to the stylistic test, C, or "Comprehension learning", score, and to the variables XC, XM, of Table 9) or "Rule Recalling" and thus related to the variables UC and UM of Table 9 and other-rote "operation learning".

Here, there are strong (but due to the classification scheme, still tentative) correlations between type of doubt in the stylistic test and type of doubt in interrogation and performance, between "global" and the subscore (the primary component of comprehension learning) $r_s = 0.75$ and between the "Rule" and the r subscore (Operation learning) $r = 0.83$

4. Conclusions and suggestions for further work.

The results reported indicate that Decision Making competence is predictable by detailed, on-line, dynamic indices and that planning which is probably one prerequisite for effective decision making is predictable from stylistic tests scores. In contrast the relatively coarse indices obtained by statistical aggregation are not of great value, at any rate in complex systems. It should be emphasised that, even though the number of subjects is fairly small, the results are much more definite than those of previous studies in this laboratory or comparably detailed studies, by other investigators, of complex decision making.

The results provide guidelines for training , on-line monitoring, the selection of decision makers and for the compositions of decision teams.

Further runs on TDS should:

(a) Complete a limited study of team configurations and
(b) Investigate the effect of variation in the size of the environment, rather than modifying its parameters.
(c) The recommendations noted as (a) to (h) in Section 2.8
(d) Regarding interrogation analysis (in contrast to tactical analysis), the interrogation indices call for refinement.
(e) The interrogation programs should be written to operate through individual spacecraft microprocessors.
(f) The sessions should be less frequent but also provide the subject with some data (an extrapolation or estimation), in return for replying.

Note: Program listings (Section 5 and Section 6) are bound after the figures.

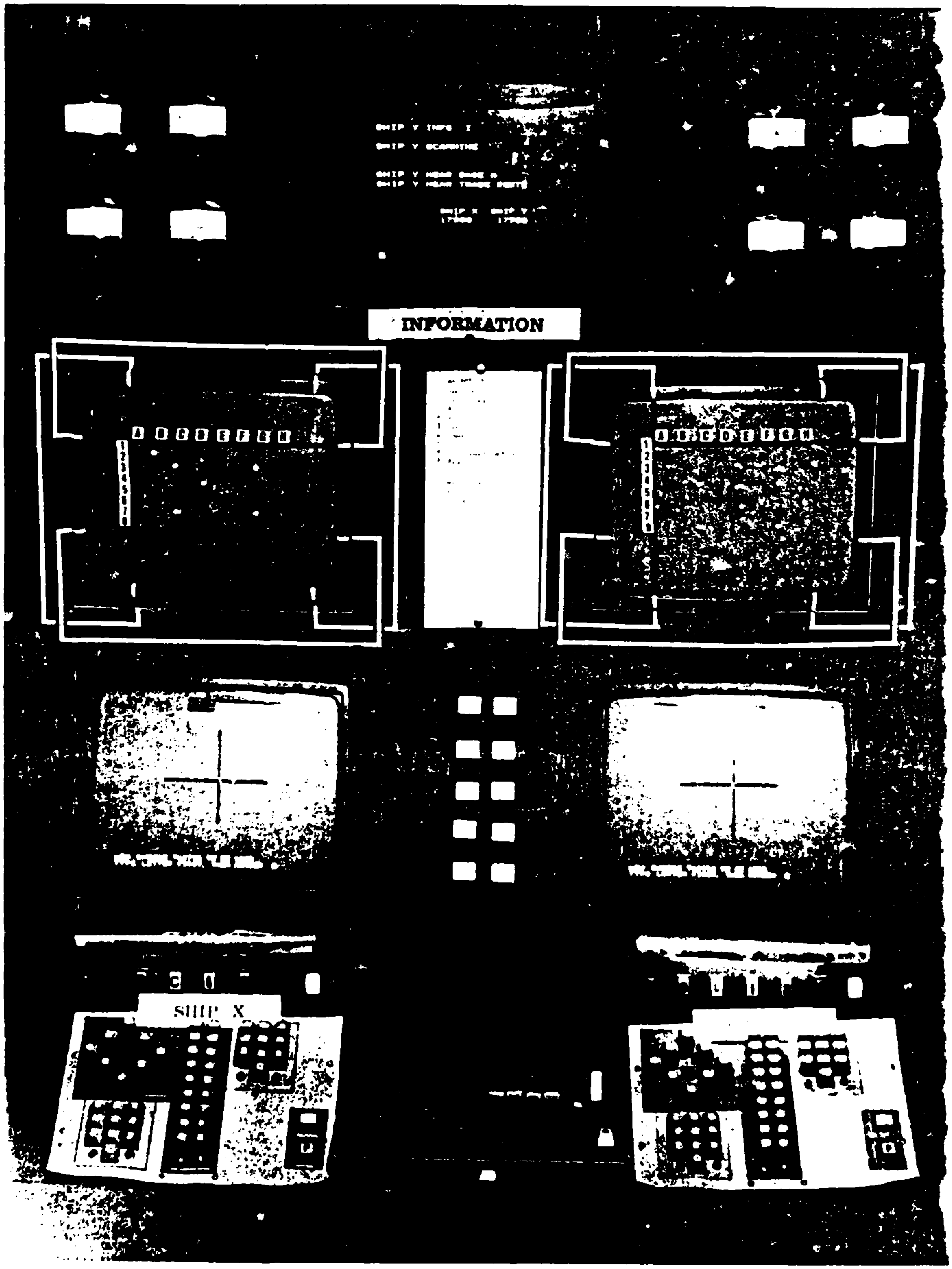
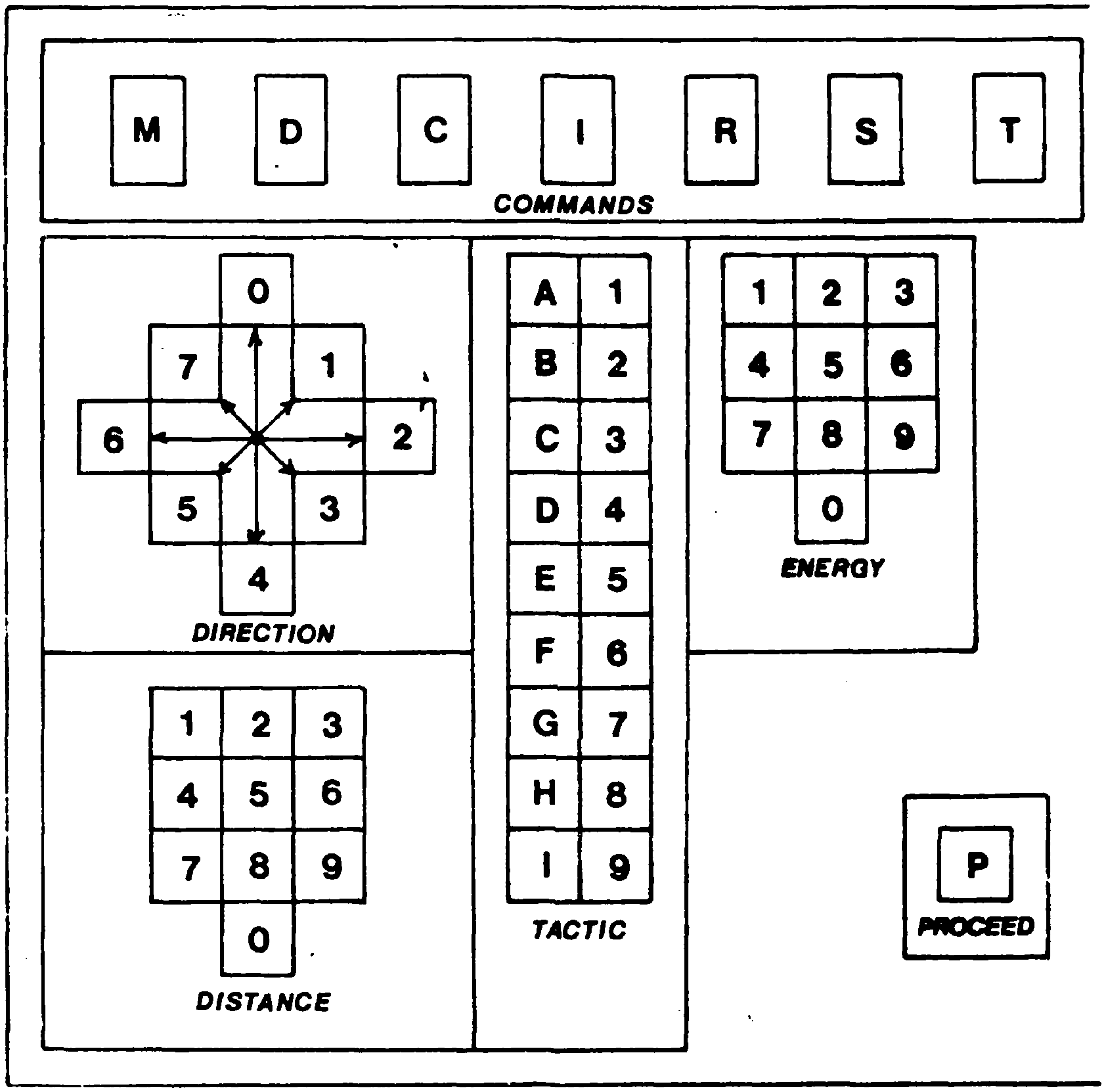


Fig 1. One Cabin with consoles for TDS. There are two cabins, both used in the two commander task. At this juncture the TDS organisation includes 4 independent microprocessors as shown in outline in Fig 2 and Fig 3, reported in previous publications

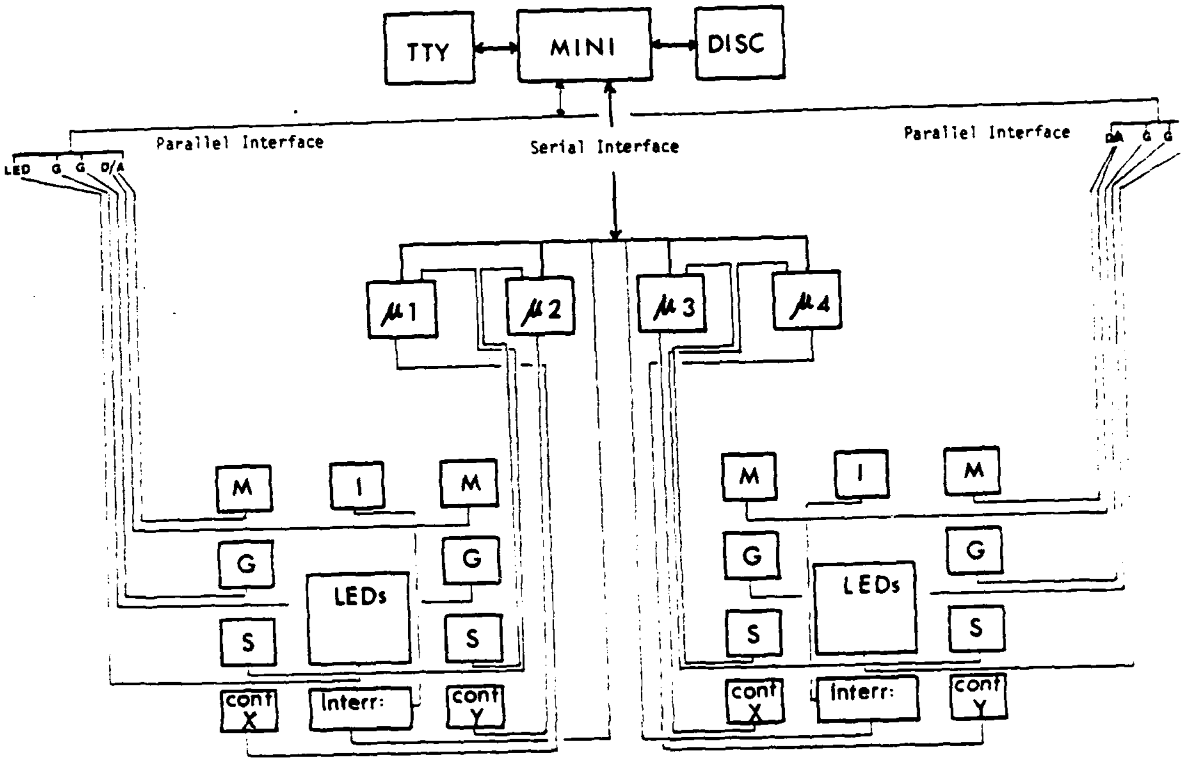


M = Move
D = Destroy
C = Conditional
I = Information

R = Repair
S = Step
T = Transfer

Fig 2: Commander's console for one ship
Each console is an input to one microprocessor only and the local scan display screens (Fig 1) are attached to the same microprocessor (spacecraft)

Tactic programs are written and stored by any command response and recalled on the alphanumeric control board.



TTY = Teletype for results printout
Mini = Alpha LSI 2 minicomputer, 32k store
Disc = Dual drive 8" floppy disc store
μ1-4 = 4 x 380Z microprocessors, 32k store
M = meters display - 'istance from bases
G = Graphics displays - positional gloual information
LEDS = "Emergencies" display panel - 4 x 60 capacity
S = display monitors - local scan displays
Cont X -Y = Ship control panels - input to μ's
Interr = keyboard used during interrogation
I = display monitor - alpha/numeric information and interrogation

Fig 3: Outline schematic of complete TDS system showing parallel interface and interrogation as well as global scan organisation of TDS, and, as in previous latest reports or Pask 1980.

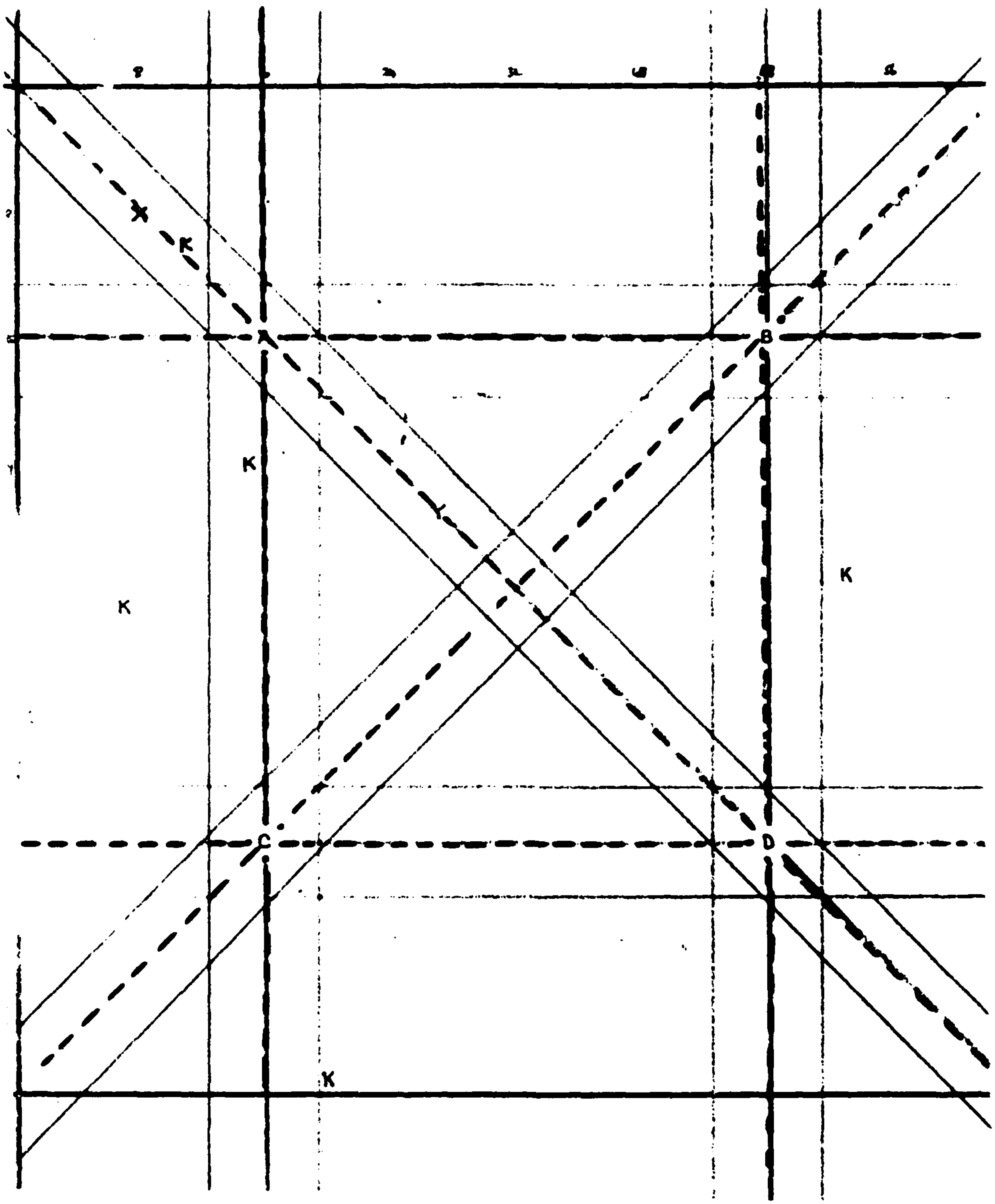
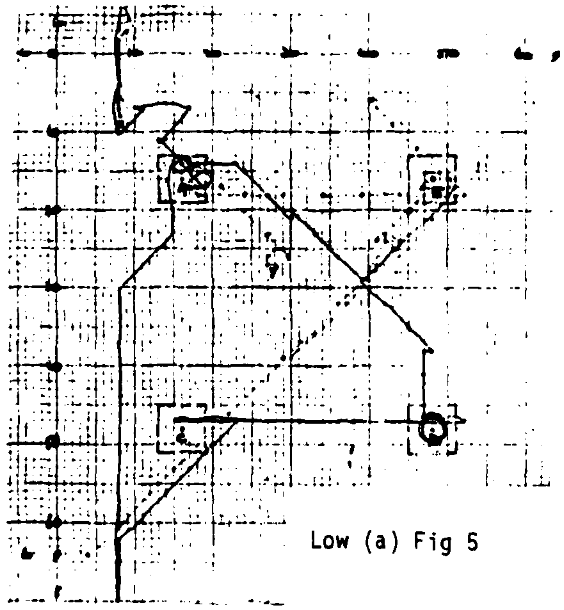
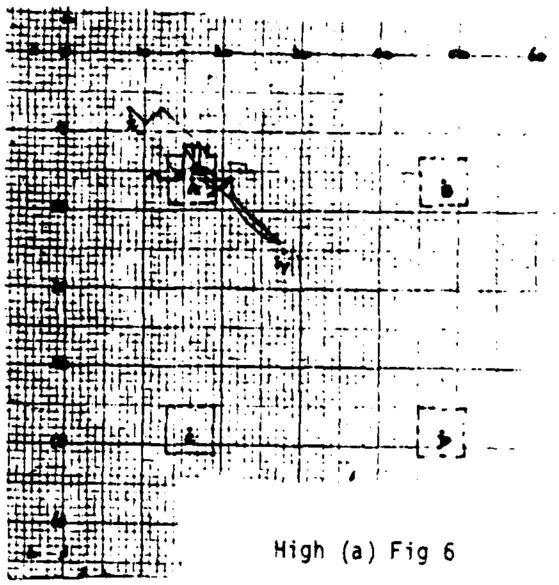


Fig 4 Initial Configuration of Space

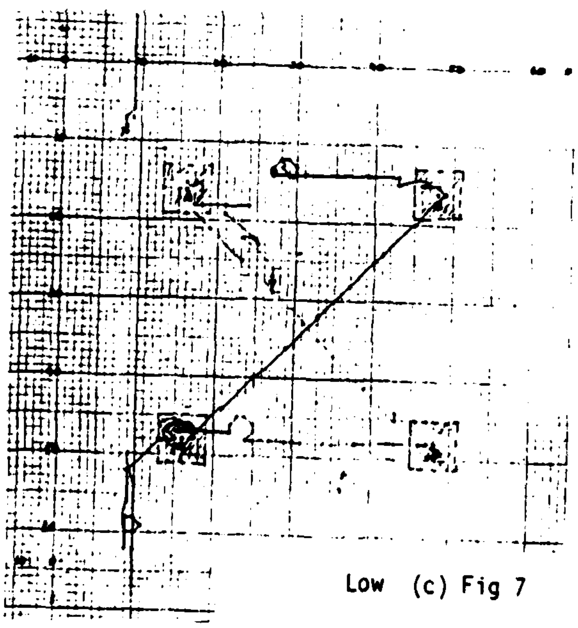
Dotted lines = trade routes
Shaded bands = "near trade routes"
K = Klingon, X & Y = Ships, A, B, C, D = bases



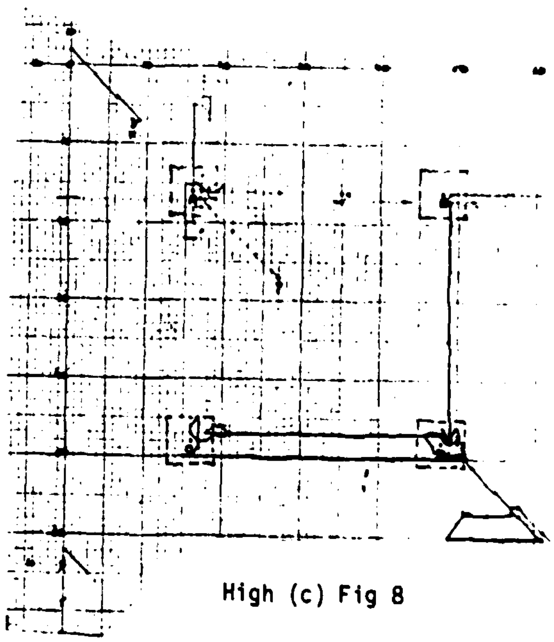
Low (a) Fig 5



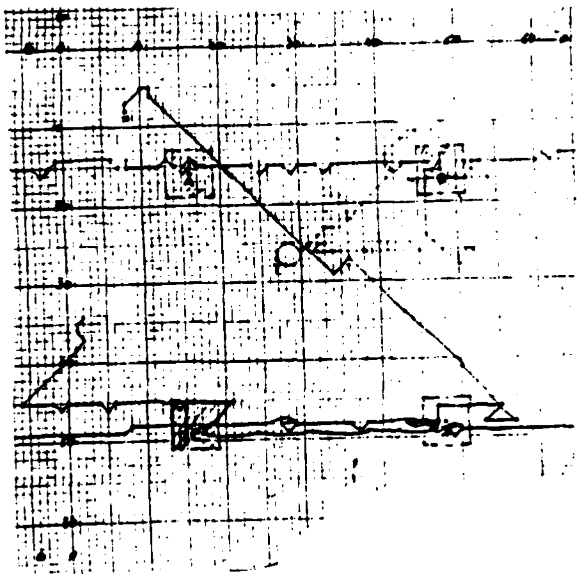
High (a) Fig 6



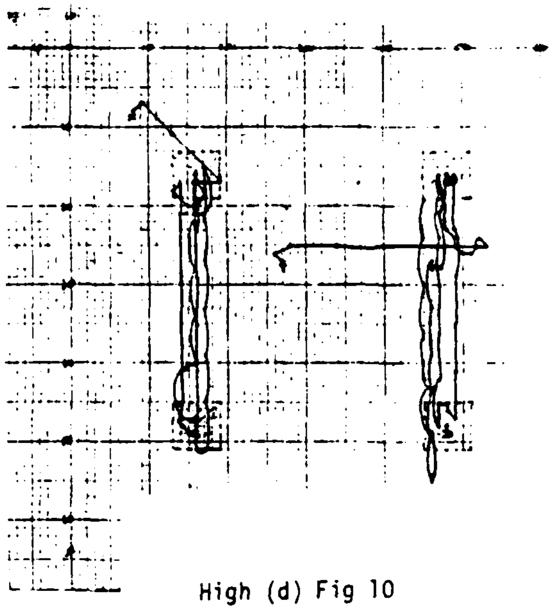
Low (c) Fig 7



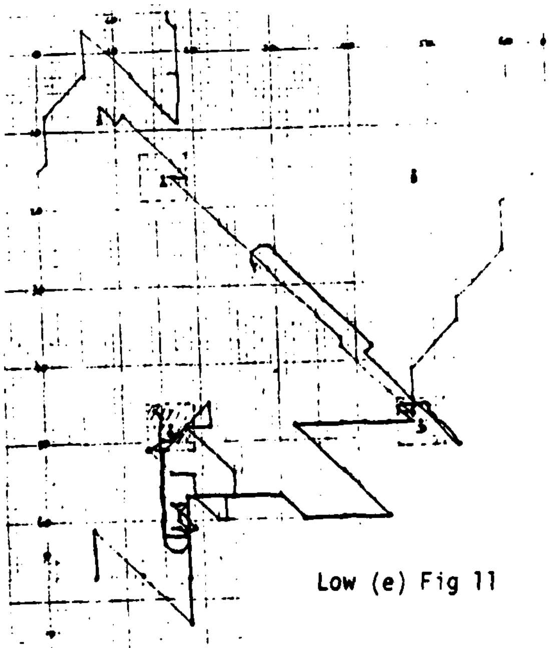
High (c) Fig 8



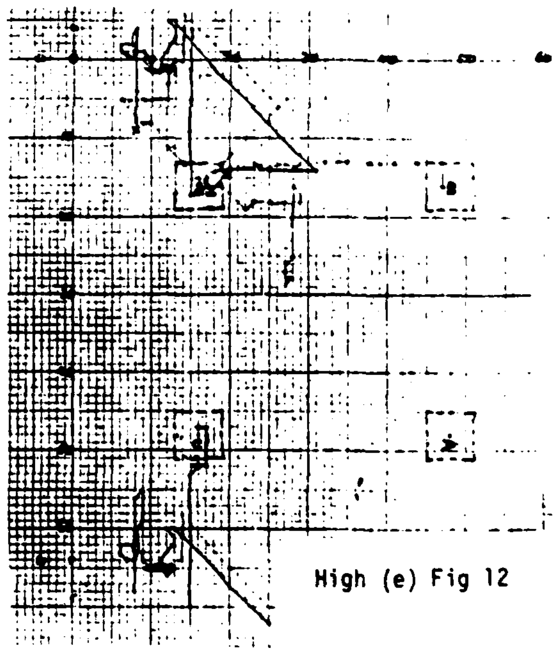
Low (d) Fig 9



High (d) Fig 10



Low (e) Fig 11



High (e) Fig 12

Section 5.

Mini (LSI 2) BASIC programs

(a) For initialisation and

(b) For running the environment, together with the interaction of spacecraft through the environment and

(c) For direct interrogation

```
0001 REM INIT
0002 REM CHECK LINES 25  96  97  WITH MAIN PROG.
16PRINT"RUNNING."
25 GOSUB 1090
30GOSUB 1125
96 GOSUB 0750
97 GOSUB 4000
98CALL(7,2,1)
100 CALL(7,2,2)
101 FOR A=23 TO 30
102 CALL(3,4,A,1)
103 NEXT A
104 REM  * ZEROS EMERGENCY LEDS  *
105 PRINT" DONE,NOW CLEAR AND LOAD MAIN PROGRAM."
106END
0750 REM ROUTINE TO SET OBJECTS
0755 LET T= 13288
0760 LET A=B=16
0765 CALL (5,T,A,B,2)
0770 LET T=14312
0775 LET A=48
0780 CALL (5,T,A,B,2)
0785 LET T=15336
0790 LET A=16
0795 LET B=48
0800 CALL (5,T,A,B,2)
0805 LET T=16360
0806 LET A=B=48
0810 CALL (5,T,A,B,2)
815  LET T=11240
0820 LET A=B=8
0825 CALL (5,T,A,B,2)
830 LET T=12264
0835 LET A=B=27
0840 CALL (5,T,A,B,2)
0845 LET A=B=15
0850 LET T=20468
0855 CALL (5,T,A,B,2)
0860 LET T=29172
0865 LET A=B=47
0870 CALL (5,T,A,B,2)
0875 LET A=49
0880 LET B=15
0885 LET T=23540
0890 CALL (5,T,A,B,2)
0895 REM
0900 LET A=17
0905 LET B=47
0910 LET T=26100
0915 CALL (5,T,A,B,2)
0920 LET T=23802
0925 LET A=48
0930 LET B=17
0935 CALL (5,T,A,B,2)
0940 LET A=48
0945 LET B=49
0950 LET T=30458
0955 CALL (5,T,A,B,2)
0960 LET A=15
0965 LET B=48
```

```
0970 LET T=28410
0975 CALL (5,T,A,B,2)
0980 LET T=30970
0985 LET A=47
0990 LET B=48
0995 CALL (5,T,A,B,2)
1000 LET T=17658
1005 LET A=17
1010 LET B=16
1015 CALL (5,T,A,B,2)
1020 LET T=21242
1025 LET A=49
1030 LET B=16
1035 CALL (5,T,A,B,2)
1036 LET T=6444
1037LET A=11
1038 LET B=10
1039 CALL (5,T,A,B,2)
1040 LET T=18682
1045 LET A=16
1050 LET B=17
1055 CALL (5,T,A,B,2)
1060 LET T=25338
1065 LET A=16
1070 LET B=49
1075 CALL (5,T,A,B,2)
1076 RETURN
1090 LET T=0
1091 FOR I=0 TO 127
1092 CALL(5,0,I,0,4)
1093 NEXT I
1095 FOR A=0TO63
1100 FOR B = 0 TO 63
1101LET T=2048*(INT(RND(0)*24+1)=1)
1102 IF T<>0 GOTO 1105
1103LET T=6444*(INT(RND(0)*48+1)=1)
1105 CALL(5,T,A,B,2)
1110 NEXT B
1115 NEXT A
1120 RETURN
1125REM *CLEARS ROUTES*
1126LET A=0
1127LET B=0
1128CALL(5,0,A,B,2)
1129LET A=A+1
1130LET B=B+1
1131CALL(5,0,A,B,2)
1132IFA+B=126 GOTO1135
1133GOTO1129
1135LET A=63
1136LET B=1
1137CALL(5,0,A,B,2)
1138LET A=A-1
1139LET B=B+1
1140CALL(5,0,A,B,2)
1141IFB=63GOTO1145
1142GOTO1138
1145LET A=0
1146LET B=16
1147CALL(5,0,A,B,2)
```

```
1148LET A=A+1
1149CALL(5,0,A,B,2)
1150IFA+B=79GOTO1155
1151GOTO1148
1155LET A=0
1156LET B=48
1157CALL(5,0,A,B,2)
1158LET A=A+1
1159CALL(5,0,A,B,2)
1160IFA+B=111GOTO1165
1161GOTO1158
1165LET A=16
1166LET B=0
1167CALL(5,0,A,B,2)
1168LET B=B+1
1169CALL(5,0,A,B,2)
1170IFB=63GOTO1175
1171GOTO1168
1175LET A=48
1176LET B=0
1177CALL(5,0,A,B,2)
1178LET B=B+1
1179CALL(5,0,A,B,2)
1180IF B=63GOTO1184
1181GOTO1178
1184RETURN
4000 LET T=6444
4005 LET A=20
4010 LET B=63
4015 CALL(5,T,A,B,2)
4016 LET A=15
4017 LET B=24
4018 CALL(5,T,A,B,2)
4020 LET A=1
4025 LET B=40
4030 CALL(5,T,A,B,2)
4035 LET A=7
4040 LET B=33
4045 CALL (5,T,A,B,2)
4050 LET A=53
4055 LET B=31
4060 CALL (5,T,A,B,2)
4065 RETURN
9999 END
```

```
1REM  *  DEMON4  EASY/NORMAL  *
2REM  *  KLING DRAIN AT 500,BASE DRAIN AT TIMES 200  *
3REM  *  DEMONS  GOES WITH DEMX46  *
4REM  *  TUES 12/2/80  *
5REM* DEMON3 HARD/DIFFICULT,KLING DRAIN AT 1000,BASE DRAIN TIMES-500 *
7CALL(6,3,0)
9PRINT"DEMON 4/3 RUNNING"
10GOSUB75
11LET N1=0
12 MAT N=ZER
13DIMF(10)
14 DIM F$(72)
15 LET G8=0
16LET H(1)=2
17LET H(2)=4
18LET H(3)=1
19LET H(4)=3
20 LET R$="XAA"
27LET E$="XY"
29MAT P=ZER
30DATA 0,-1,1,-1,1,0,1,1,0,1,-1,1,-1,0,-1,-1
35LET L=1
40LET B7=1
45LET A$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
46LETJ$="  I H#*789XYABCDQQQQQQQQQQQQQQQQQQQQQ"
50LET N$="0123456789"
55LET C$="MSRDCIG1234567"
65 LET E(0)=20000
66 LET E(1)=20000
67LET X=X1=Y=Y1=8
68LET X2=Y2=27
70 GOTO 99
75REM SCROLL UP AND CLEAR SCREEN
80FOR I=1 TO 16
85PRINT
90NEXTI
91RETURN
99LET B(0)=B(1)=1
125LET A=1
132FORB=0TO 15
133READ A(B)
134NEXTB
135MAT READ M
136GOSUB9700
138FOR B= 1 TO 15
139NEXT B
165FOR B= 1 TO 500
166NEXT B
168CALL(6,3,0)
169GOSUB 6023
170PRINT
171GOSUB 262
172LET C=1
173LET X=Y=27
174GOSUB262
176GOTO0190
181PRINT
182CALL(6,3,0)
183FORA= 0TO 150
184NEXTA
```

```
188GOSUB6021
190GOTO3350
191FORA=0TO13
195IF I$(0,0)=C$(A,A) GOTO0211
196NEXT A
205CALL(6,3,0)
206 GOTO235
211IF(A=5)+(A=12)GOTO 205
212LET A=A+1
213LET F1=0
214IF (A>7)*(C=0) GOTO1125
215IF(A<8)*(C=1)GOTO1125
216LET K$(N1,N1)=C$(A-1,A-1)
218LET Z$(N1,N1)=" "
219IF M$="X" GOTO 222
220IF M$=" "GOTO 3350
222 ON A GOTO 230,245,240,255,250,235,257,230,245,240,255,250,235,257
225GOTO0205
230IF C=0 GOTO500
231PRINT"SHIP Y MOVING"
232GOTO502
235GOSUB 262
237GOTO7000
240 REM REPAIR
241GOTO1800
245GOTO1270
250PRINT"CHECKING CONDITIONS."
253GOTO 168
255REM INFO
256GOTO2100
257REM
262REM  *  SCAN  *
265IFC=0GOTO 268
266PRINT"SHIP Y SCANNING"
267GOTO 269
268PRINT"SHIP X SCANNING"
269LET F$=F$(0,1)
270FOR B=Y-3 TO Y+3
272 LET B2=MOD(B,64)
274 LET N=N+1
276FOR A=X-3 TO X+3
278 LET A2=MOD(A,64)
300 CALL(5,T,A2,B2,1)
302 LET T1=INT(T/1024)
304 LET F$(G8,G8)=J$(T1,T1)
306 LET G8=G8+1
310IF T1<4 GOTO 363
312IF T1=6 GOTO 325
314IF T1>16 GOTO0340
316IF T1>11 GOTO 336
318 ON T1 GOTO 363,363,363,363,363,325
320 GOTO 330
324REM ENERGY LOSS DUE TO KLINGON
325 LET E(4)=500
326 LET F1=1
327 LET K9=K9+1
328 GOTO 363
330 LET T1=T1-6
332 ON T1 GOTO 325,363,363,363,363
334 GOTO363
```

```
336 LET T1=T1-11
338 ON T1 GOTO 345,350,355,360,363
340 LET F9=F9+1
342 GOTO 363
345GOSUB3245
346 GOTO363
350GOSUB 3260
351 GOTO363
355GOSUB 3275
356 GOTO 363
360GOSUB 3290
361 LET F8=4
363 NEXT A
364 NEXT B
365REM
366 GOSUB 7380
367 LET E(C)=E(C)-E(4)
369GOSUB 4880
370 CALL(8)
373 LET G8=0
374 LET F(C)=F1
375RETURN
500PRINT"SHIP X MOVING"
502LET T5=1
503GOSUB740
504LET E=A
505LET T5=2
506GOSUB740
507LET F=A
508LET T9=F1=L1=0
585FORD=1TOF
590LET A1=X+A(E*2)
595LET B1=Y+A((E*2)+1)
600LET A1=MOD(A1,64)
605LET B1=MOD(B1,64)
606REM 0T064
610CALL (5,T,A1,B1,1)
615LET T1=INT(T/1024)
617 IF T1=2 GOTO 701
620IF T1=0 GOTO0701
621IF (T1>11)*(T1<16) GOTO0623
622GOTO0628
623LET T3=T1
624IF (F-D)<>0 GOTO0628
625LET D1=1
627GOTO0646
628LET E(C)=E(C)-1000
630PRINTTAB(9);"DANGER"
635PRINT "REVERSE THRUST APPLIED"
636REM
640REM
641IF E(C)>500 THE N 0645
642LET E(C)=500
645PRINT
646 LET A1=A1-A(E*2)
647LET B1=B1-A((E*2)+1)
648LET A1=MOD(A1,64)
649LET B1=MOD(B1,64)
650LET D=F
701LET T=0
```

```
702CALL(5,0,X,Y,2)
703LET X=A1
704LET Y=B1
708IF E(C)<=500 GOTO0711
710LET E(C)=E(C)-50
711NEXTD
712IF C=1 GOTO0715
713LET T=11240
714GOTO0717
715LET T=12264
717CALL (5,T,A1,B1,2)
718GOSUB1158
720REM THIS IS "MOVEA"
721 IF M$<>"X" GOTO723
722LET M$(0,0)=" "
723GOSUB 262
724GOTO7000
740FORA=0TO9
745IFI$(T5,T5)=A$(A,A) GOTO765
750 NEXT A
755 GOTO 7000
765REM
766RETURN
825 IF(Z8=1)*(Z9=1) GOTO6230
826 IF Z9=1 GOTO 853
827 IF B9=1 GOTO 850
830 CALL(6,4,0)
835 LET B9=1
840 RETURN
850 IF Z8=1 GOTO 830
851 IF B9=0 GOTO826
853 CALL(6,5,0)
855 LET B9=0
860 RETURN
1125REM  *  CHANGE SHIPS  *
1127IF C=1 GOTO1145
1128 LET X=X2
1129 LET Y=Y2
1130 LET C=1
1132 IF M$(0,0)<>"X"GOTO1138
1134 LET A=8
1136 GOTO 216
1138REM CALL(8)
1140 GOTO 216
1145 LET X=X1
1146 LET Y=Y1
1147 LET C=0
1149 IF M$(0,0)<>"X" GOTO1155
1151 LET A=1
1153 GOTO 216
1155REM CALL(8)
1157 GOTO 216
1158 IF C=1 GOTO1164
1160 LET X1=X
1161 LET Y1=Y
1162 RETURN
1164 LET X2=X
1165 LET Y2=Y
1166 RETURN
1270REM THIS IS DESTROY
```

```
1280CALL(6,3,0)
1281IFC=0GOTO1284
1282PRINT"SHIP Y ATTACKING"
1283GOTO1285
1284PRINT"SHIP X ATTACKING"
1285 REM
1300LET T5=1
1305GOSUB740
1306LET E=A
1310LET T5=2
1315GOSUB740
1320LET F=A
1325LET T9=0
1330LET M9=F*100
1400FORB=Y-3TOY+3
1405LET B2=MOD(B,64)
1410FORA=X-3TOX+3
1415LET A2=MOD(A,64)
1420CALL(5,T,A2,B2,1)
1425LET T1=INT(T/1024)
1430IF(T1<6)+(T1>7)THEN1505
1431IFE(C)-M9>499THEN1435
1432PRINT"SHIP ENERGY TOO LOW TO DESTROY"
1433GOTO1520
1435LET K1=T-INT(T/1024)*1024
1440PRINTM9;TAB(9);"UNIT HIT"
1445LET K1=K1-M9
1450IFK1>0GOTO1505
1455CALL(5,0,A2,B2,0)
1460LET H1=H1+1
1465GOSUB5940
1470IFM9<400GOTO1505
1474REM  *CHECK WEAK LINES  *
1475GOTO2600
1480CALL(5,4096,A2,B2,2)
1485LET H2=H2+1
1490GOTO1505
1495CALL(5,(T1*1024)+K1,A2,B2,2)
1500REM
1503IFE=1THEN1520
1505NEXTA
1510NEXTB
1520CALL(8)
1525CALL(6,3,0)
1530PRINT"NO.OF KLINGONS DESTROYED=";H1
1535LET T(6,1)=T(6,1)+H1
1540PRINT
1545LET H1=0
1550IFH2=0GOTO1570
1555PRINTH2;" HOLES MADE "
1560LET T(6,2)=T(6,2)+H2
1565LET H2=0
1570IFH3=0GOTO1590
1575PRINT"CRACK ! "
1580LET T(6,4)=T(6,4)+H3
1585LET H3=0
1590GOSUB 262
1595GOTO 7000
1800REM REPAIR
1801CALL(6,3,0)
```

```
1802IFC=0GOTO1805
1803PRINT"SHIP Y ATTEMPTING REPAIR"
1804GOTO1806
1805PRINT"SHIP X ATTEMPTING REPAIR"
1806REM
1807 LET T5=1
1810GOSUB 740
1815LET E=A
1820IFABS(X1-X2)<4 GOTO 1840
1825PRINT" ONLY ONE SHIP IN RANGE - REPAIR IMPOSSIBLE "
1830PRINT
1835GOTO1950
1840IFABS(Y1-Y2)<4 GOTO 1850
1845GOTO1825
1850 IF (Z8=1)+(Z9=1) GOTO1825
1855FORB=Y-3TOY+3
1860LET B2=MOD(B,64)
1865FORA=X-3TOX+3
1870LET A2=MOD(A,64)
1875CALL(5,T,A2,B2,1)
1880LET T1=INT(T/1024)
1890IFT1<>4 GOTO1910
1895IFE<>1 GOTO1930
1900CALL(5,0,A2,B2,2)
1902 LET T(5,4)=T(5,4)+1
1905GOTO1930
1910IFT1<>5 GOTO1930
1915IFE<>2 GOTO1930
1920CALL(5,0,A2,B2,2)
1930NEXT A
1935NEXT B
1940LET E(0)=E(0)-300
1945LET E(1)=E(1)-300
1950GOSUB 262
1955GOTO 7000
2100CALL(6,3,0)
2101 LET T5=1
2102 GOSUB 740
2103 LET A9=A
2105 IF C=0 GOTO2108
2106PRINT"SHIP Y INFO ";A9
2107GOTO2110
2108PRINT"SHIP X INFO ";A9
2110IF A9=7 GOTO2114
2111IF A9=8 GOTO2141
2112IF A9=9 GOTO 2152
2113GOTO2134
2114LET P1=INT((X1+8)/8)
2115LET P2=INT((Y1+8)/8)
2116LET R1=INT((X2+8)/8)
2117LET R2=INT((Y2+8)/8)
2118 LET N$(P1,P1)=A$(P1,P1)
2119 PRINT"SHIP X";A$(P1-1,P1-1);P2
2120 LET N$(R1,R1)=A$(R1,R1)
2121 PRINT"SHIP Y";A$(R1-1,R1-1);R2
2125 GOTO2400
2133REM OLD 2134 WASCALL(7,A9,B7+1)
2134 CALL(7,A9,(C+1))
2140GOTO2400
2141REM TRADE ROUTES
```

```
2142PRINT V7;"TRADE ROUTES BLOCKED"
2143PRINT "DUE TO CRACKS."
2144REM
2150GOTO2400
2152REM STARBASES
2155FORI=1TO4
2157LET T(I,4)=T(I,3)
2158PRINT "STARBASE ";A$(I-1,I-1);" ";T(I,4)
2159LET T(I,2)=1
2160NEXTI
2161REM
2166GOTO2400
2400LET E(C)=E(C)-400
2401PRINT
2402LET Z$(N1,N1)=N$(A9,A9)
2421REM CALL(8)
2423REM
2424GOSUB 262
2425GOTO7000
2600REM CHECK WEAK LINEES
2625IF (A2<61)*(A2>2) GOTO2665
2630REM DO VERT CRAK
2635LET H3=H3+1
2640LET T=5120
2645FORB=0TO63
2650CALL (5,T,0,B,2)
2655NEXTB
2656 IF V1=1 GOTO 2658
2657 LET V7=V7+4
2658 LET V1=1
2660GOTO1505
2665REM
2670IF (B2<61)*(B2>2) GOTO2710
2675REM HORIZONTA
2680LET H3=H3+1
2685LET T=5120
2690FORA=0TO63
2695CALL (5,T,A,0,2)
2700NEXTA
2701 IF V2=1 GOTO2703
2702 LET V7=V7+4
2703 LET V2=1
2705GOTO1480
2710GOTO1480
2996CALL(6,3,0)
2997GOSUB0075
2998REM INTEERR BLOCK L
2999PRINT"STARSHIP CONTROL"
3000PRINT"WANTS SOME ANSWERS"
3001PRINT"TO THE FOLLOWING-"
3002PRINT"INTERROGATION SESSION NUMBER ";L+1
3005LET L=L+1
3007PRINT
3010PRINT "ANSWER USING 1 LINE UN"
3011PRINT "-LESS DIRECTED OTHERWISE."
3012PRINT "PRESS RETURN AT THE"
3013PRINT "END OF EACH LINE."
3014PRINT "IF YOU CAN'T ANSWER"
3015PRINT "TYPE NA (NOT APPLICABLE)"
3018PRINT
```

```
3020PRINT
3030LET G$="QUES"
3032IF L<10 GOTO3042
3035LET G$(4,4)="1"
3037LET G$(5,5)=N$(L-10,L-10)
3040GOTO3046
3042LET G$(4,4)="0"
3045LET G$(5,5)=N$(L,L)
3046CALL(1,G$)
3047CALL(1,1,2)
3048PRINT
3049PRINT"INTERROGATION SESSION  ";L;
3050PRINT
3051FORI=1TO6
3052FORJ=1TO6
3053PRINT INT(T(I,J));TAB(10*J);
3054NEXT J
3055PRINT
3056NEXT I
3057PRINT
3065 GOTO4000
3066FORJ=1TO8
3067LET H$="QFORMS"
3068CALL(1,H$)
3075LET A=INT(D(M(L,J))/10)
3076CALL(1,2,1)
3077IF A=0 GOTO3082
3078FORI=1TOA
3079INPUT Q$
3080NEXTI
3082LET A1=INT (D((M(L,J))+1)/10)
3084FORI=1TO(A1-A)
3085LET Q$(1,31)="                                        "
3086INPUT Q$
3087LET M$=Q$(0,0)
3088PRINT Q$(1,31)
3089LET Q$(1,31)="                                        "
3090IFQ$(0,0)="O"GOTO3165
3091LET W9=(M$="M")
3092LET W9=W9+((M$="N")*2)
3093IFW9<>0GOTO3110
3094LET W8=(M$="X")
3095LET W8=W8+((M$="Y")*2)
3097LET W8=W8+((M$="W")*3)
3100LET W8=W8+((M$="L")*4)
3107GOTO3140
3110IFW9<>1GOTO3116
3112PRINTT(H(W9),3)
3115GOTO3165
3116IFT(H(W9),2)<>1GOTO3119
3117PRINTT(H(W9),4)
3118GOTO3165
3119PRINTT(H(W9),3)
3120GOTO3165
3140PRINTA$(H(W8)-1,H(W8)-1)
3165NEXTI
3166CALL(1,-2)
3167PRINT "RESPONSE(S) PLEASE."
3168LET A1=D((M(L,J)+1))-(A1*10)
3169FORI=1TOA1
```

```
3170IF AI=1 GOTO3173
3171CALL(1,1,1)
3172PRINT A$(I-1,I-1);")";
3173CALL(1,1,2)
3174PRINT "QUESTION ";J;" PART ";I
3175CALL(1,1,1)
3187INPUT Q$
3190CALL(1,1,2)
3192PRINT Q$
3195CALL(1,1,1)
3197PRINT "HOW CONFIDENT (0-10) ";
3207INPUT Q$
3210CALL(1,1,2)
3211PRINT Q$
3212NEXTI
3213CALL(1,1,1)
3214FORI9=1TO4
3215PRINT
3216NEXTI9
3217NEXTJ
3218CALL(1,-1)
3219CALL(1,1,1)
3241GOSUB3331
3242 MAT N=ZER
3243RETURN
3245LET T(1,1)=1
3247LET F8=1
3255GOTO8100
3260LET T(2,1)=1
3262LET F8=2
3270GOTO8100
3275LET T(3,1)=1
3277LET F8=3
3285GOTO8100
3290LET T(4,1)=1
3300GOTO8100
3331FORI=1TO4
3332FORJ=1TO 2
3333LET T(I,J)=0
3334NEXTJ
3336NEXTI
3337RETURN
3350REM
3351GOSUB3382
3352 GOSUB 825
3353GOSUB3382
3354PRINT 1
3355 LET N=30
3356LET B=0
3357REM
3358LET M$=" "
3359REM T9=0
3360CALL(13,M$,B)
3365LET N=N-1
3370 IF N=0 GOTO3350
3371IF B=0 GOTO 3360
3372 INPUT I$
3373 IF I$(3,5)="   " GOTO 3376
3374 LET R$=I$(3,63)+J$(B9+10,B9+10)
3375 GOTO3377
```

```
3376 LET RS=IS(0,2)
3377IF B9=1 THEN 3380
3378LET VS=RS
3379GOTO 3381
3380LET PS=RS
3381GOTO 3385
3382FORI=1TO15
3383NEXTI
3384RETURN
3385FOR I=1TO5
3386CALL(13,MS,B)
3387NEXT I
3388GOSUB 3382
3389CALL(6,3,0)
3390REM
3391PRINT
3399GOTO 191
4000 REM
4001 PRINT
4002PRINT"CRACKS ";V1;V2;
4008PRINT
4009PRINT
4010PRINT"ROUTES BLOCKED ";V7;
4011PRINT
4012PRINT
4085PRINT"                CO-ORDS                              TACTICS "
4086PRINT"   SHIP X           SHIP Y        TACTIC    PART       TACTIC    PART"
4087REM
4088FOR I=0TON1
4089 FOR J=1TO8
4090PRINTN(J,I);TAB(8*J)
4091 NEXT J
4092PRINT
4093NEXT I
4094 GOTO 3066
4095REM  STORE SHIP CO-ORDS
4096 LET N(1,N1)=X1
4097 LET N(2,N1)=Y1
4098 LET N(3,N1)=X2
4099 LET N(4,N1)=Y2
4105RETURN
4880REM MAINTAIN T RECORDS
4882REM LOSSTOKLINGS
4885LET T(5,5)=T(5,5)+E(4)
4887LET E(4)=0
4890IF K9<T(5,1) GOTO4900
4895LET T(5,1)=K9
4900LET K9=0
4905RETURN
5940LET A3=MOD(A2+32,64)
5945LET B3=MOD(B2+32,64)
5950FORA4=A3TOA3+6
5955LET A4=MOD(A4,64)
5960FORB4=B3TOB3+6
5965LET B4=MOD(B4,64)
5970CALL(5,T,A4,B4,1)
5971IFT=0GOTO5990
5975NEXTB4
5980NEXTA4
5985RETURN
```

```
5990LET T=6444
5995CALL(5,T,A4,B4,2)
6000RETURN
6021IFE(0)<501GOTO6027
6022IFE(1)<501GOTO6029
6023PRINTTAB(9);"SHIP X   SHIP Y"
6024PRINTTAB(8);E(0);TAB(17);E(1)
6025RETURN
6026REM
6027PRINT"SHIP Y";E(1)
6028RETURN
6029PRINT"SHIP X";E(0)
6030RETURN
6040REM
6050 IF C=1GOTO6064
6051IFE(0)<501GOTO6203
6055REM*SHIP X X1  Y1 *
6060LET S8=X1
6061LET S9=Y1
6062GOTO6070
6064IFE(1)<501GOTO6207
6065LET S8=X2
6066LET S9=Y2
6070REM*
6075LET O(1)=16-S8
6080LET O(2)=16-S9
6085LET O(3)=48-S8
6090LET O(4)=16-S9
6095LET O(5)=16-S8
6100LET O(6)=48-S9
6105LET O(7)=48-S8
6110LET O(8)=48-S9
6115FOR I=1TO 9
6120IF O(I)>-1 GOTO6130
6125LET O(I)=O(I)-(2*O(I))
6130IF O(I)<33 GOTO6140
6135LET O(I)=32-(O(I)-32)
6140NEXT I
6145FOR I=0TO 3
6150 LET R(I)=O((I*2)+1)
6155 IF O((I*2)+2)<O((I*2)+1) GOTO6165
6160LET R(I)=O((I*2)+2)
6165LET R(I)=256-(R(I)*8)
6170NEXT I
6180REM R(0 TO 3)=BASES 0-255
6185REM 0=FARTHEST  255= NEAREST
6190FOR I=0 TO 3
6200CALL(4,R(I),(C*4)+I+1)
6201 NEXT I
6202 RETURN
6203FOR M=1TO4
6204CALL(4,0,M)
6205 NEXT M
6206 RETURN
6207FORS=5 TO 8
6208CALL(4,0,S)
6209 NEXT S
6210GOTO6211
6211RETURN
6230PRINT" BOTH SHIPS OUT OF ENERGY "
```

```
6231GOSUB 2996
6232GOSUB 75
6233PRINT "CALL THE SUPERVISOR "
6235PRINT
6236STOP
7000GOSUB 6040
7001LET M$(0,0)=" "
7005REM NO SOUNDS ANY MORE!
7006FORI=0TO1
7007LET T(5+I,3)=E(I)
7008NEXTI
7009 GOSUB4095
7010 GOSUB 8200
7011REM
7012LET N1=N1+1
7015IF D1=1 GOTO7045
7020IFN1<20THEN7040
7025REM INTERROGATION NOW
7026 GOSUB 2996
7027LET N1=0
7030REMGOSUB262
7040GOTO181
7045REM IN DOCK POSITION
7046CALL(6,3,0)
7047PRINT
7048PRINT
7050REM IN DOCK POSITION
7051IF D1=2GOTO7020
7052 GOSUB7075
7053PRINT"YOU HAVE";E(C);"ENERGY AVAILABLE"
7054PRINT"HOW MUCH DO YOU WANT TO INVEST IN THIS STARBASE";
7055INPUT I9
7056IF I9<=E(C) GOTO7059
7057PRINT"TOO MUCH"
7058GOTO7053
7059LET E(C)=E(C)-I9
7060LET T1=T3
7068LET T(T3-11,5)=T(T3-11,5)+I9
7069PRINT T(T3-11,5);"  =TOTAL INVESTMENT"
7070REM THIS IS "DOCK1"
7071IF D1=2 THEN7020
7072LET D1=2
7073LET E(C)=INT(T(T1-11,3)/4+E(C))
7074GOTO7081
7075IF C=0 GOTO7078
7076PRINT"SHIP Y -- DOCKED "
7077GOTO 7079
7078PRINT"SHIP X -- DOCKED "
7079PRINT
7080RETURN
7081PRINT
7082PRINT"      REFUELLED"
7083PRINT
7100GOTO7020
7200REM NEAR TRADE ROUTES
7201IF C=1 GOTO7210
7202IF((Y1>12)*(Y1<20))+((Y1>44)*(Y1<52)) GOTO7206
7203IF((X1>12)*(X1<20))+((X1>44)*(X1<52)) GOTO 7206
7204IF((X1+Y1)>56)+(ABS(X1-Y1)<7) GOTO7206
7205GOTO7220
```

```
7206PRINT"SHIP X NEAR TRADE ROUTE "
7207 REM NEAR ROUTES FLAG
7208CALL(3,4,23,0)
7209GOTO7218
7210IF((X2>12)*(X2<20))+((X2>44)*(X2<52)) GOTO7214
7211IF((Y2>12)*(Y2<20))+((Y2>44)*(Y2<52)) GOTO7214
7212IF((X2+Y2)>56)+(ABS(X2-Y2)<7) GOTO7214
7213GOTO7218
7214PRINT"SHIP Y NEAR TRADE ROUTE "
7215REM NEAR ROUTES FLAG
7216CALL(3,4,23,0)
7218PRINT
7220RETURN
7380 LET F$=F$+"0000000"
7381PRINT
7385 FOR I=23 TO 31
7386 CALL(3,4,I,1)
7387 NEXT I
7390 LET F$(50,50)=N$(F1,F1)
7391 IF F1=0 GOTO 7399
7392 CALL(3,4,26,0)
7399 IF E(0)>500 GOTO7411
7400 LET E(0)=500
7402REM X OUT COND FLAG
7405 LET Z9=1
7406 CALL(5,0,X1,Y1,0)
7408 CALL(3,4,29,0)
7411 IF E(1)>500 GOTO7423
7412 LET E(1)=500
7414REM Y OUT COND FLAG
7417 LET Z8=1
7418 CALL(5,0,X2,Y2,0)
7420 CALL(3,4,29,0)
7423 IF E(0)*E(1)<501 GOTO7440
7426 IF E(0)>10000 GOTO 7435
7429 LET F$(51,51)="1"
7432 CALL(3,4,27,0)
7435 IF E(1)>10000 GOTO7440
7438 LET F$(52,52)="1"
7439CALL(3,4,27,0)
7440 FOR I=1TO4
7441 LET T(I,3)=T(I,3)-INT(RND(0)*200)
7442 LET T(F8,3)=T(F8,3)+(F9*1000)
7443REM
7447 IF T(I,3)>2000 GOTO7456
7450REM
7453 CALL(3,4,30,0)
7456 IF T(I,3)>10000 GOTO7465
7459 LET F$(53,53)="1"
7462 CALL(3,4,28,0)
7465 NEXT I
7466 IF(Z8=0)*(Z9=0) GOTO7469
7467REM
7468 GOTO 7476
7469 IF(ABS(X1-X2)<4)+(ABS(X1-X2)>58) GOTO7471
7470 GOTO7476
7471 IF (ABS(Y1-Y2)<4)+(ABS(Y1-Y2)>58) GOTO 7473
7472 GOTO 7476
7473 CALL(3,4,25,0)
7474 PRINT" NEAR OTHER SHIP "
```

```
7475REM
7476 PRINT
7480 IF F8=0 GOTO7488
7481 IF C=0 GOTO7485
7482PRINT"SHIP Y NEAR BASE ";A$(F8-1,F8-1);
7483 LET F$(55,55)="1"
7484 GOTO7487
7485PRINT"SHIP X NEAR BASE ";A$(F8-1,F8-1);
7486 LET F$(54,54)="1"
7487CALL(3,4,24,0)
7488PRINT
7489 LET F8=F9=0
7490GOSUB 7200
7501 LET F$="     !"+F$
7502IFC=0 THEN 7506
7503LET R$=P$
7504CALL(6,5,0)
7505GOTO7508
7506LET R$=V$
7507CALL(6,4,0)
7508 IF LEN(R$)>3 GOTO 7510
7509GOSUB 7521
7510GOSUB7530
7514PRINT F$;R$(0,59)
7515 GOSUB 7530
7516 CALL(6,3,0)
7517 GOSUB 7530
7520RETURN
7521 LET R$=" "
7522 FOR I=1TO59
7523 LET R$=R$+" "
7524 NEXT I
7525 RETURN
7530FOR G8=50 TO 1 STEP -1
7535NEXTG8
7540RETURN
8100REM
8102IFV(1)=T1GOTO8185
8105LET V(1)=T1
8110LET G(1)=T1
8115FORI=1TO4
8120IFH(1)<>T1GOTO8130
8125LET H(I)=0
8130NEXTI
8135FORI=1TO4
8140IFH(I)=0GOTO8170
8145IFI=4GOTO8160
8150LET G(I+1)=H(I)
8155GOTO8170
8160LET G(4)=H(I)
8165GOTO8170
8170NEXTI
8175MAT H=G
8180MAT G=ZER
8185RETURN
8200REM STORE ELEMENTS
8205 FOR I=1TO9
8210 IF I$(60,60)=A$(I-1,I-1) GOTO8220
8215 NEXT I
8216 LET S2=S3=99
```

```
8217 GOTO 8270
8220 LET S2=(I-1)*9
8225 FOR I=1TO9
8230 IF I$(61,61)=N$(I,I) GOTO 8240
8235 NEXT I
8240 LET S2=S2+I
8245 IF I$(59,59)=" " GOTO8250
8247 LET S2=S2/10
8250 FOR I=0 TO 17
8255 IF I$(62,62)=A$(I,I) GOTO8265
8260 NEXT I
8265 LET S3=I
8270 LET N((C*2)+5,N1)=S2
8275 LET N((C*2)+6,N1)=S3
8280RETURN
9000END
9700REM INITIAL IZE QUESTS
9702LET X$(5,8)="ABCD"
9710LET L=0
9712FORI=0TO23
9714READ D(I)
9716NEXTI
9718DATA 2,1,0,3,4,9,20,21
9720DATA 0,3,5,10,12,13,14,22
9722FORI=0TO23
9724READ J
9726LET D(I)=D(I)*10+J
9728NEXTI
9730DATA 1,5,6,11,13,14,15,17
9737 LET T(1,3)=T(2,3)=T(3,3)=T(4,3)=20000
9740FORI=0TO9
9741READ S(I)
9742NEXTI
9743RETURN
9744DIMZ$(40)
9746DIM J$(72)
9747DIM O(10)
9748DIM R(4)
9949DIMH(4)
9950DIMG(4)
9951DIMV(2)
9952DIMC(72)
9954 DIM N(8,40)
9955 DIM V$(72)
9956 DIM P$(72)
9957 DIM R$(72)
9958 DIM K$(72)
9959DIM H$(6)
9960DIM S(15)
9961DIM P(4,6,2)
9962DIM B(2)
9963DIM D(30)
9964DIM X$(9)
9965DATA 1,3,7,9,10,11,13,14
9966DATA 0,7,8,11,13,14,15,16
9967DATA 2,3,4,6,14,20,21,22
9968DATA 2,4,5,9,13,14,20,22
9969DATA 7,8,10,12,14,15,16,21
9970DATA 6,8,9,11,14,16,17,18
9971DATA 0,7,10,14,15,17,18,19
```

```
9972DATA 1,2,4,11,14,16,18,19
9973DATA 6,8,12,14,18,19,21,22
9974DATA 0,2,5,7,14,18,19,20
9975DATA 1,3,8,9,14,18,19,22
9976DATA 4,6,11,13,14,16,18,19
9977DATA 5,10,12,14,15,17,18,19
9978DATA 0,2,4,6,8,12,14,16,18,20,31,37,44
9979DATA 48,50,54,58,65,72,76,86,94,102,103
9980DATA0,1,1,1,1,2,1,1,2,1,2,2,3,2,1,1,1,1,1,1,1,1,1,1
9981DATA 0,0,15,15,47,15,15,47,47,47
9982DIM T(8,8)
9983DIM M(16,8)
9987DIM Q$(72)
9989DIM K(20)
9990DIM G$(6)
9991DIM M$(1)
9992DIM E$(2)
9993DIM A(15)
9994DIM I$(72)
9995DIM N$(10)
9996DIM C$(20)
9998 DIM A$(26)
9999DIM E(5)
```

Section 6.

Microprocessor programs, one for each of up to four spacecraft, loaded in each one. The programs are written in RML BASIC for the 280Z machine.

```
   X
10 REM * DEMX51 * FROM 50 * 26/2/80 *
20 REM LINE1070 AND
30 CLEAR 5000
40 DIM SC$(2,40)
50 DIM D2(10)
60 D2(1)=-7:D2(2)=-6:D2(3)=1:D2(4)=8
70 D2(5)=7:D2(6)=6:D2(7)=-1:D2(8)=-8
80 POKE 16911,62
90 POKE 16912,65
100 COMM$="                MOVING        DESTROYING    "
110 COMM$=COMM$+"CONDITIONAL  INFORMATION  "
120 COMM$=COMM$+"REPAIR       REPEATING    "
130 COMM$=COMM$+"TRANSFERRING "
140 ?"SHIP X OR Y ";
150 SH$=CHR$(USR(1)):?SH$
160 IF SH$<> "X" AND SH$<>"Y" THEN 140
170 ?"YOU HAVE ABOUT 30SECS TO CHANGE KEYBOARD ";SH$
180 FOR I= 1 TO 30000:NEXT I
190 ?"NOW PRESS THE P BUTTON ON THE SHIP KEYBOARD ";SH$
200 X=USR(3)
210 IF USR(1)=0 THEN 210
220 S3$="MDCIRST":S5$="0123456789"
230 S6$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
240 IFSH$="X"THENS4$="MSCDRIG1254367"ELSES4$="1254367MSCDRIG"
250 IFSH$="X"THENS9$="MSCDRIG7"ELSES9$="125436G7"
260 S8$="MDCIRSXY"
270 REM
280 DIM Z2(40,18)
290 DIM Z3(40,18)
300 DIM Z(120)
310 PRINT CHR$(17)
320 A$="ABCDEFG7654321"
330 IF SH$="Y" THEN 360
340 T$="MBBMEESBHDHAMDFMBBMFBXAA"
350 GOTO370
360 T$="1BB1CC1DD2BF4CA6FAXAA"
370 ? CHR$(12)
380 GRAPH 1
390 FOR I= 1 TO 7
400 PLOT 16+(I*6),47,ASC(MID$(A$,I,1))
410 PLOT 16,(I*6)-3,ASC(MID$(A$,I+7,1))
420 NEXT I
430 GOTO 450
440 REM IF USR(3)<>0 THEN 1800
450 S1$=MID$(S1$,1,0)
460 Z=USR(0)
470 IF Z=38 THEN 2190
480 IF Z<>33THEN 460
490 FORI=1TO56:Z(I)=USR(0):NEXT:Z=USR(0):Z=USR(0)
500 FORI=57TO112:Z(I)=USR(0):NEXT
510 FOR I=1TO112:IF Z(I)=38 GOTO 2190
520 NEXT I
530 IF USR(3)<>0 THEN 2190
540 FOR I=1 TO112:S1$=S1$+CHR$(Z(I)):NEXT I
550 IF USR(3)<>0 THEN 2190
560 REMIF Z<>13 THENS1$=S1$+CHR$(Z):Z=USR(0):GOTO207
570 FOR I=1TO49
580 IF USR(3)<>0 THEN 2190
590 IF MID$(S1$,I,1)=MID$(S2$,I,1)GOTO760
600 GOSUB 620
610 GOTO 680
620 X1=I-(7*(INT((I-1)/7)))
630 Y1=INT((I-1)/7)+1
640 X1=20+((X1-1)*6)
650 Y1=43-((Y1-1)*6)
660 X1=X1+3:Y1=Y1-2
670 RETURN
```

```
680 AS=ASC(MID$(S1$,I,1))
690 IF AS=73THENPL=42:GOTO760
700 IFAS=81THENPL=24:GOTO760
710 IFAS=42THENPL=11:GOTO760
720 IFAS=72THENPL=15:GOTO760
730 IFAS=35THENPL=124:GOTO760
740 PL=AS
750 PLOT X1,Y1,ASC(MID$(S1$,I,1))
760 PLOT X1,Y1,PL :NEXT I
770 IFMID$(S1$,57,3)="   "THEN900
780 CS=CS+1:T1$=MID$(S1$,57,54)+"XAAXAA"
790 ST$=MID$(S1$,111,2)
800 ?:? MID$(ST$,1,1);ST$;" RECEIVED"
810 FOR I=1TO9
820 IF MID$(ST$,1,1)=MID$(S6$,I,1) GOTO 840
830 NEXTI:GOTO900
840 S2=(I-1)*9:FOR I=1TO9
850 IF MID$(ST$,2,1)=MID$(S5$,I+1,1) THEN 870
860 NEXTI:GOTO900
870 S2=S2+VAL(MID$(ST$,2,1))
880 S2$=MID$(S2$,1,0)
890 SC$(1,S2)=T1$
900 S2$=MID$(S2$,1,0)
910 S2$=S1$
920 FOR I= 1 TO 200:NEXT I
930 REM NOW CHECK FOR INTERRUPT REQUEST
940 REM
950 REM NO REQUEST SOGET NEXT ELEMENT
960 REM NEXT ELEMENT ROUTINE
970 REM IF Z1 =0 THEN NO TACTIC OPERATIVE
980 REM Z1 IS TACTIC NO. OPERATIVE
990 GOTO 1010
1000 ?"CONDITION MET"
1010 REM
1020 X=USR(3):IFX<>0THEN2190
1030 IFZ1=0THENTP$="   ":E1=0:GOTO2120
1040 E$=MID$(T$,(E1*3)+1,3)
1050 E1=E1+1
1060 REM NOW INTERPRET ELEMENT E$
1070 IF E$<>"XAA" THEN 1110
1080 ?"TERMINATING THIS TACTIC"
1090 Z1=0:E1=0:GOTO2120
1100 REM ABOVE LINE SENDS TO DEFAULT
1110 FORA=1TO14
1120 IFMID$(E$,1,1)=MID$(S4$,A,1)THEN1140
1130 NEXT A
1140 IFA>7THENA=A-7
1150 IF A=7THEN1170
1160 E$=MID$(S4$,A,1)+MID$(E$,2,2)
1170 ?"NEXT COMMAND: ";MID$(COMM$,(13*A),13);
1180 ?"(";TP$;")"
1190 IF MID$(E$,1,1)<>"M" AND MID$(E$,1,1)<>"1" THEN 1550
1200 FORI=1TO 9
1210 IF MID$(E$,2,1)=MID$(S6$,I,1)THEN DR=VAL(MID$(S5$,I,1)):GOTO 1240
1220 NEXT I
1230 FOR I= 1 TO 1000:NEXT I
1240 FOR I= 2 TO 10
1250 IF MID$(E$,3,1)=MID$(S6$,I,1)THEN TH=VAL(MID$(S5$,I,1)):GOTO 1270
1260 NEXT I
```

```
1270 IF TH>4 THEN TH=4
1280 DR=DR+1
1290 D3=D2(DR)
1300 I=25:GOSUB 620
1310 FOR A= 1 TO TH
1320 IF A=4 THEN 1500
1330 NWS=MIDS(S2S,I+D3,1)
1340 IF NWS<>" " THEN 1530
1350 S2S=MIDS(S2S,1,(I+D3)-1)+SHS+MIDS(S2S,I+D3+1,75)
1360 IF A>1THEN 1380
1370 S2S=MIDS(S2S,1,24)+" "+MIDS(S2S,26,75)
1380 FOR K2= 1 TO 3
1390 PLOT X1,Y1,ASC(SHS)
1400 FOR K= 1 TO 100:NEXT K
1410 PLOT X1,Y1,32
1420 NEXT K2
1430 I=I+D3:GOSUB 620
1440 FOR K2= 1 TO 3
1450 PLOTX1,Y1,32
1460 FOR K= 1 TO 100:NEXT K
1470 PLOT X1,Y1,ASC(SHS)
1480 NEXT K2
1490 IF A<>4 THEN 1520
1500 PLOT X1,Y1,32
1510 S2S=MIDS(S2S,1,I-1)+" "+MIDS(S2S,I+1,75)
1520 NEXT A
1530 IF NWS=" " THEN 1540
1540 GOTO1900
1550 IF MIDS(ES,1,1)<>"I"AND MIDS(ES,1,1)<>"6" THEN 1660
1560 IF Z2(Z1,E1)=1 THEN 1620
1570 FOR I= 0 TO 9
1580 IF MIDS(ES,2,1)=MIDS(S6S,I+1,1) THEN Z3(Z1,E1)=I:GOTO1610
1590 NEXT I
1600 ?"524":STOP
1610 Z2(Z1,E1)=1
1620 IFZ3(Z1,E1)=0 THEN 1650
1630 Z3(Z1,E1)=Z3(Z1,E1)-1
1640 E1=0 : GOTO1020
1650 Z2(Z1,E1)=0:Z1=0:GOTO 1010
1660 IF MIDS(ES,1,1)<>"G" AND MIDS(ES,1,1)<>"7" THEN 1730
1670 REM TRANSFER
1680 S9=0
1690 IFSHS="X"ANDMIDS(ES,1,1)="7"THENS9=1
1700 IFSHS="Y"ANDMIDS(ES,1,1)="G"THENS9=1
1710 S2=VAL(MIDS(ES,2,2)):GOTO3750
1720 GOTO 1010
1730 REM
1740 IF MIDS(ES,1,1)<>"C" AND MIDS(ES,1,1)<>"5" THEN 1890
1750 ?"CHECKING CONDITION"
1760 FOR A=1TO 7
1770 IF MIDS(ES,2,1)=MIDS(S6S,A,1) THEN 1790
1780 NEXT A
1790 IF MIDS(S2S,49+A,1)="1"ANDMIDS(ES,3,1)="B"GOTO1000
1800 IF MIDS(S2S,49+A,1)="0"ANDMIDS(ES,3,1)="C"GOTO1000
1810 ?"CONDITION NOT MET-COMMAND SKIPPED"
1820 IF MIDS(MIDS(TS,(E1*3)+1,3),1,1)="C" THEN GOTO 1850
1830 IF MIDS(MIDS(TS,(E1*3)+1,3),1,1)="5" THEN GOTO 1850
1840 E1=E1+1:GOTO 1000
1850 E1=E1+1
1860 IF MIDS(MIDS(TS,(E1*3)+1,3),1,1)="C" THEN GOTO 1850
1870 IF MIDS(MIDS(TS,(E1*3)+1,3),1,1)="5" THEN GOTO 1850
1880 E1=E1+1:GOTO 1000
1890 REM PRINT OUT TYPE DESCRIP
1900 REM NOW SEND TO MINI
1910 IFSC=LSCANDSC<>0THEN 1960
1920 IFSC<>LSCTHEN1950
1930 FORI=1TO6:ES=ES+"             ":NEXTI
1940 ES=ES+"  ":GOTO1980
```

```
1950 LSC=LSC+1:ALS=LSC
1960 TP=SC:SC=ALS:GOSUB 3400:SC=TP
1970 E$=E$+MID$(SC$(0,ALS),1,54)+ST$
1980 IFLEN(TP$)=0THENTP$="  "
1990 E$=E$+TP$+MID$(S6$,E1+1,1)
2000 FORI=1TO6
2010 IF USR(0)=38 THEN 2190
2020 NEXT I
2030 FORI=1TO500:NEXT I
2040 LPRINTCHR$(X)
2050 FORI=1TO 500:NEXT I
2060 LPRINT E$
2070 FORI=1TO 200:NEXT I
2080 FOR I= 1 TO 2
2090 IF USR(0)=38 THEN I=I-1
2100 NEXT I
2110 GOTO440
2120 IF SH$="X" THEN E$="M" ELSE E$="1"
2130 E$=E$+MID$(S6$,D4+1,1)
2140 D4=D4+1
2150 IF D4=8 THEN D4=0
2160 E$=E$+"B"
2170 ?"DRIFT"
2180 GOTO 1190
2190 REM
2200 IF MID$(S2$,25,1)=SH$ THEN 2260
2210 FOR I=1TO49
2220 IF MID$(S2$,I,1)<>SH$ THEN 2240
2230 GOSUB 620:PLOT X1,Y1,ASC(" "):GOTO 2250
2240 NEXT I
2250 I=25:GOSUB620:PLOTX1,Y1,ASC(SH$)
2260 X=PEEK(25661)
2270 Z1=1
2280 E1=0
2290 GOSUB 2350
2300 GOTO3350:REM STORE NEW STRING
2310 FOR I=1TO20:NEXT I
2320 X=USR(0)
2330 FORI=1TO500:NEXT I
2340 GOTO 1010
2350 T$=MID$(T$,1,0)
2360 Z7=0
2370 ?:?:?:?:Z7=Z7+1
2380 ?T$
2390 IF Z7=1 THEN I$=CHR$(X):GOTO 2430
2400 IF Z7=19 THEN I$="T":GOTO 2430
2410 REM
2420 ?"COMMAND ";Z7;:I$=CHR$(USR(1)):?I$
2430 IFI$="T" ANDZ7=1AND CS+SC=0 THEN 2420
2440 IFI$="T"ANDZ7=1 THEN3530
2450 REM WANT TO TRANSFER MANUALLY
2460 IFI$="P"ANDZ7<>1THENT$=T$+"XAAXAA":RETURN
2470 FORA=1TO7
2480 IF I$=MID$(S3$,A,1)THEN 2510
2490 NEXT A
2500 PRINT:PRINT:?:GOTO2420
2510 I$=MID$(S4$,A,1)
2520 ONAGOTO 2540,2690,2920,3060,3130,3200,3270
2530 GOTO2500
2540 REM MOVE
2550 ?:?:?:?"MOVE DIRECTION ";
2560 D$=CHR$(USR(1)):?D$
2570 FOR A=1TO8
2580 IFD$=MID$(S5$,A,1)THEN 2610
2590 NEXT A
```

```
2600 ?:?:?:GOTO2350
2610 D$=MID$(S6$,A,1)
2620 ?"THRUST ";:F1$=CHR$(USR(1)):?F1$
2630 FOR A=2 TO 10
2640 IF F1$=MID$(S5$,A,1)THEN 2660
2650 NEXT A:?:?:?:GOTO2620
2660 F1$=MID$(S6$,A,1)
2670 T$=T$+I$+D$+F1$
2680 GOTO 2370
2690 REM DESTROY
2700 ?"1OR ALL IN RANGE (1 OR 2) ";
2710 D$=CHR$(USR(1)):?D$
2720 GOSUB2730:GOTO2780
2730 FOR A=1 TO 10
2740 IFD$=MID$(S5$,A,1)THEN 2770
2750 NEXT A
2760 ?:?:?:GOTO2700
2770 RETURN
2780 IF A<>2ANDA<>3THEN 2700
2790 D$=MID$(S6$,A,1)
2800 ?"ENERGY (1-9) ?";
2810 F1$=CHR$(USR(1)):?F1$
2820 GOSUB2880
2830 IFA>0ANDA<11THEN 2850
2840 ?:?:?:GOTO2800
2850 F1$=MID$(S6$,A,1)
2860 T$=T$+I$+D$+F1$
2870 GOTO2370
2880 FOR A= 1 TO 9
2890 IFF1$=MID$(S5$,A,1)THEN 2910
2900 NEXT A
2910 RETURN
2920 REM CONDITION
2930 ?"CONDITION (1-7) ";
2940 D$=CHR$(USR(1)):?D$
2950 FOR A= 2 TO 8
2960 IFD$=MID$(S5$,A,1)THEN2980
2970 NEXT A:?:?:?:GOTO2920
2980 T$=T$+I$
2990 T$=T$+MID$(S6$,A,1)
3000 PRINT"TRUE OR NOT TRUE (1 OR 2)";
3010 D$=CHR$(USR(1)):PRINT D$
3020 FOR A=2 TO 3
3030 IF D$=MID$(S5$,A,1)GOTO 3050
3040 NEXT A:?:?:?:GOTO 3000
3050 T$=T$+MID$(S6$,A,1):GOTO 2370
3060 ?:?:?:?"INFORMATION-OPTION (1-9) ";
3070 D$=CHR$(USR(1)):?D$
3080 FORA=2TO10
3090 IF D$=MID$(S5$,A,1)THEN3110
3100 NEXTA:?:GOTO3060
3110 T$=T$+I$
3120 T$=T$+MID$(S6$,A,1)+"A":GOTO 2370
3130 ?:?:?:?"REPAIR HOLES OR CRACKS (1 OR 2) ";
3140 D$=CHR$(USR(1)):?D$
3150 FOR A=2 TO 3
3160 IF D$=MID$(S5$,A,1)THEN3180
3170 NEXT A:?:GOTO3130
3180 T$=T$+I$
3190 T$=T$+MID$(S6$,A,1)+"A":GOTO2370
3200 ?:?:?:?"STEP HOW MANY (1-9) ";
3210 D$=CHR$(USR(1)):?D$
3220 FOR A=1TO10
3230 IF D$=MID$(S5$,A,1) THEN3250
3240 NEXT A:?:GOTO3200
3250 T$=T$+I$
3260 T$=T$+MID$(S6$,A,1)+"A":GOTO2370
3270 REM TRANSFER
3280 ?"TRANSFER TO- ? ";
```

```
3290 GOSUB 3560:ST$=STR$(S2)
3300 IFS9=1ANDSH$="X" THEN I$="7"
3310 IFS9=1ANDSH$="Y" THEN I$="G"
3320 ?"S2= ";S2;"ST$= ";ST$
3330 IFLEN(ST$)=3THEN ST$=MID$(ST$,2,2)
3340 T$=T$+I$+ST$:GOTO2370
3350 REM STORE STRING
3360 ?:?:?:?"THIS CODE NUMBER WILL IDENTIFY"
3370 ?"THIS TACTIC FOR FUTURE USE,NOTE IT.  ";
3380 SC=SC+1
3390 GOSUB 3400:GOTO 3470
3400 NUMB=9*((SC/9)-INT(SC/9))
3410 IF NUMB=0 THEN NUMB=9
3420 LE=INT((SC/9)+1)
3430 IF (SC/9)-INT(SC/9)=0 THEN LE=LE-1
3440 ST$=MID$(S6$,LE,1)
3450 ST$=ST$+MID$(S5$,NUMB+1,1)
3460 RETURN
3470 ?ST$
3480 FORI=1TO250:NEXT
3490 SC$(0,SC)=T$
3500 IF LEN(SC$(0,SC))=60 THEN 3520
3510 SC$(0,SC)=SC$(0,SC)+" ":GOTO 3500
3520 REM
3530 ?"NOW CHOOSE TACTIC TO BE USED"/
3540 ?"TYPE LETTER FIRST, THEN NUMBER  ";
3550 GOSUB 3560:GOTO3750
3560 ST$=CHR$(USR(1)):?ST$;
3570 ST$=ST$+CHR$(USR(1)):?MID$(ST$,2,1);
3580 IF MID$(ST$,1,1)=MID$(ST$,2,1) THEN 3600
3590 ?:S9=0:GOTO3650
3600 FOR I= 1TO 9
3610 IF MID$(ST$,1,1)=MID$(S6$,I,1) THEN 3630
3620 NEXT I:GOTO 3680
3630 S9=1:ST$=MID$(ST$,1,1)+CHR$(USR(1))
3640 ?MID$(ST$,2,1)
3650 FOR I=1TO9
3660 IF MID$(ST$,1,1)=MID$(S6$,I,1)THEN 3690
3670 NEXT I
3680 ?:?:?:?:?"ERROR,DO IT AGAIN":GOTO 3530
3690 S2=(I-1)*9
3700 FOR I= 1 TO 9
3710 IF MID$(ST$,2,1)=MID$(S5$,I+1,1) THEN 3730
3720 NEXT I: GOTO3680
3730 S2=S2+VAL(MID$(ST$,2,1))
3740 RETURN
3750 IFS9=1THEN3790
3760 IF S2=SC THEN 3790
3770 IF S2<SC THEN 3790
3780 ?ST$;"NOT AVAILABLE":Z1=0:GOTO1010
3790 T$=SC$(S9,S2)
3800 TP=SC:SC=S2:GOSUB3400
3810 SC=TP:TP$=ST$
3820 IFS9=1THENTP$=MID$(TP$,1,1)+TP$
3830 IFS9=0THENTP$=" "+TP$
3840 IF LEN(T$)<3 GOTO 3780
3850 Z1=S2:E1=0
3860 GOTO2310
```

```
3870 ?"SHIP "SHS" TACTICS"
3880 FORW=1TO18
3890 ?RIGHT$("     "+STR$(W),4);
3900 NEXTW:?
3910 FOR W=1TO40
3920 IFSC$(0,W)=""THEN4000
3930 ?LEFT$(STR$(W)+"    ",3);
3940 FORI=1TO18
3950 IFMID$(SC$(0,W),(I*2)+(I-2),3)="XAA"THEN3990
3960 S7$=MID$(SC$(0,W),(I*2)+(I-2),3)
3970 GOSUB4170:?S7$;
3980 NEXTI:?
3990 ?:NEXTW:?:?
4000 IFSH$="X"THENS9$="125436G7"ELSES9$="MSCDRIG7"
4010 IFSH$="X"THENSH$="Y"ELSESH$="X"
4020 ?:?
4030 ?"SHIP "SH$" SENT THESE"
4040 FORW=1TO18
4050 ?RIGHT$("     "+STR$(W),4);
4060 NEXTW:?
4070 FOR W=1TO40
4080 IFSC$(1,W)=""THEN4160
4090 ?LEFT$(STR$(W)+"    ",3);
4100 FORI=1TO18
4110 IFMID$(SC$(1,W),(I*2)+(I-2),3)="XAA"THEN4150
4120 S7$=MID$(SC$(1,W),(I*2)+(I-2),3)
4130 GOSUB4170:?S7$;
4140 NEXTI:?
4150 ?:NEXTW:?:?
4160 END
4170 REMS7$ HOLDS 3 CHTS
4180 FORJ=1TO8
4190 IFMID$(S7$,1,1)=MID$(S9$,J,1)THEN4210
4200 NEXTJ
4210 S7$=MID$(S8$,J,1)+MID$(S7$,2,2)+" "
4220 RETURN
```

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